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(54) Abstract Title

A reception unit for performing seamless switches between video signals using a vertical blanking interval switch

(57) A receiver for receiving television programming is capable of performing seamless switches between separate video signals. The receiver includes a microprocessor (564) to control the selection of RF channels and two tuners (560A, 560B) for tuning to separate RF channels. Each RF channel may carry an analog signal, or a digital signal. Two digital demodulators (568A, 568B) are provided, and are each connected to a respective tuner for demodulating a digital signal in the respective RF channel. Similarly, two analog demodulators (569A, 569B) are provided and are each connected to a respective tuner for demodulating an analog signal in the respective channel. A digital demultiplexer/decoder (572) is connected to receive the demodulated digital signal from the selected RF channel, to demultiplex and decompress the received digital signal and to apply the resultant signal to a digital display processor (576). An analog display processor (580) formats for display any analog signal selected and demodulated. A vertical blanking interval switch (588) is connected to the output of the digital display processor (584) and to the output of the analog display processor (580) for seamlessly switching between the video signals.

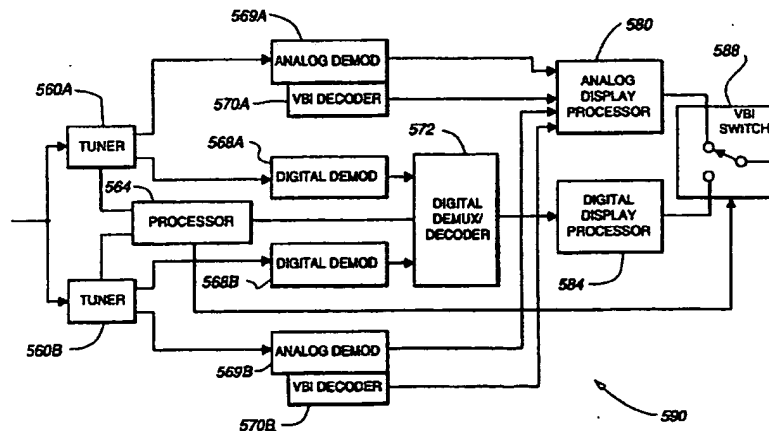


Fig. 17

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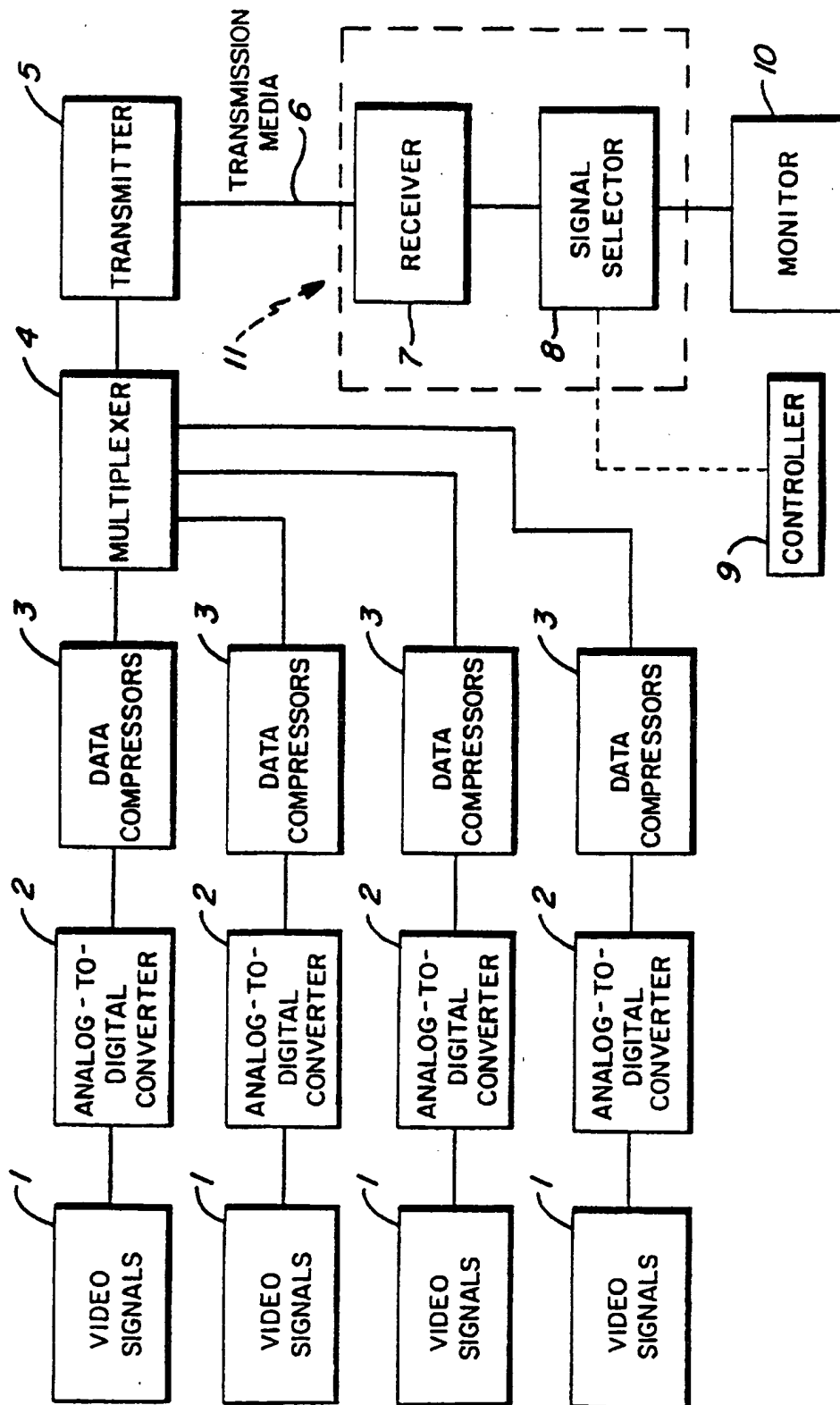
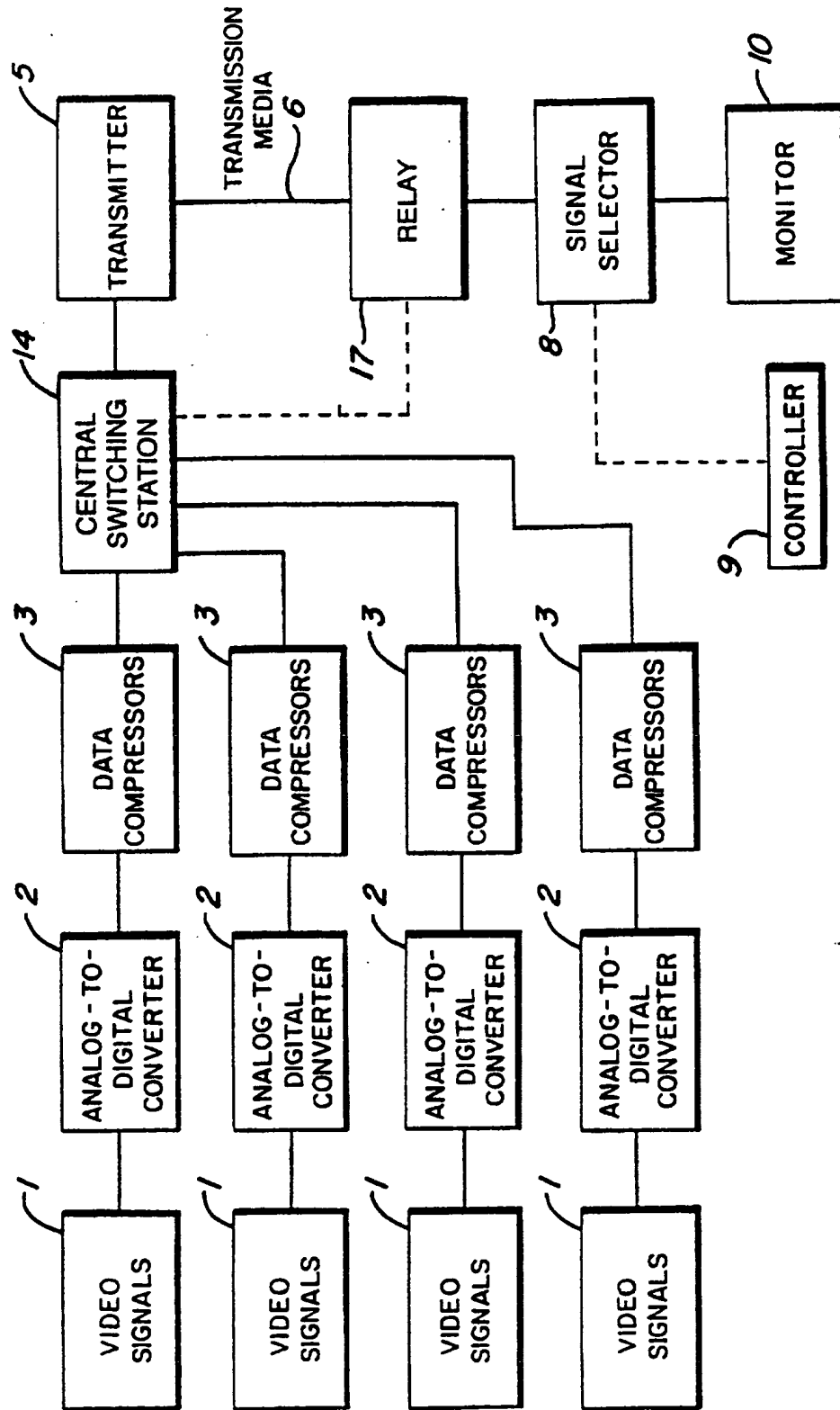


Fig. 1

**Fig. 2**

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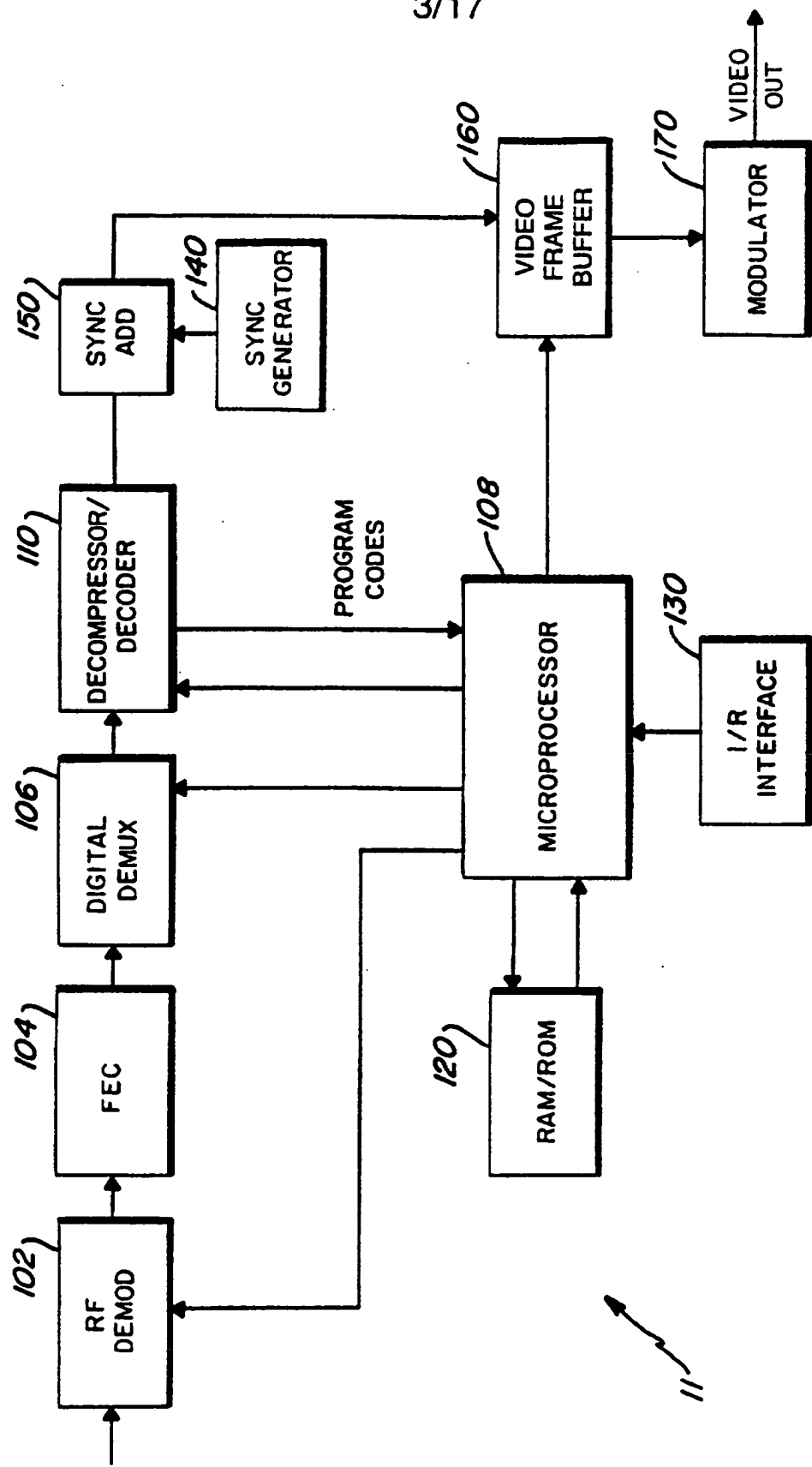


Fig. 3

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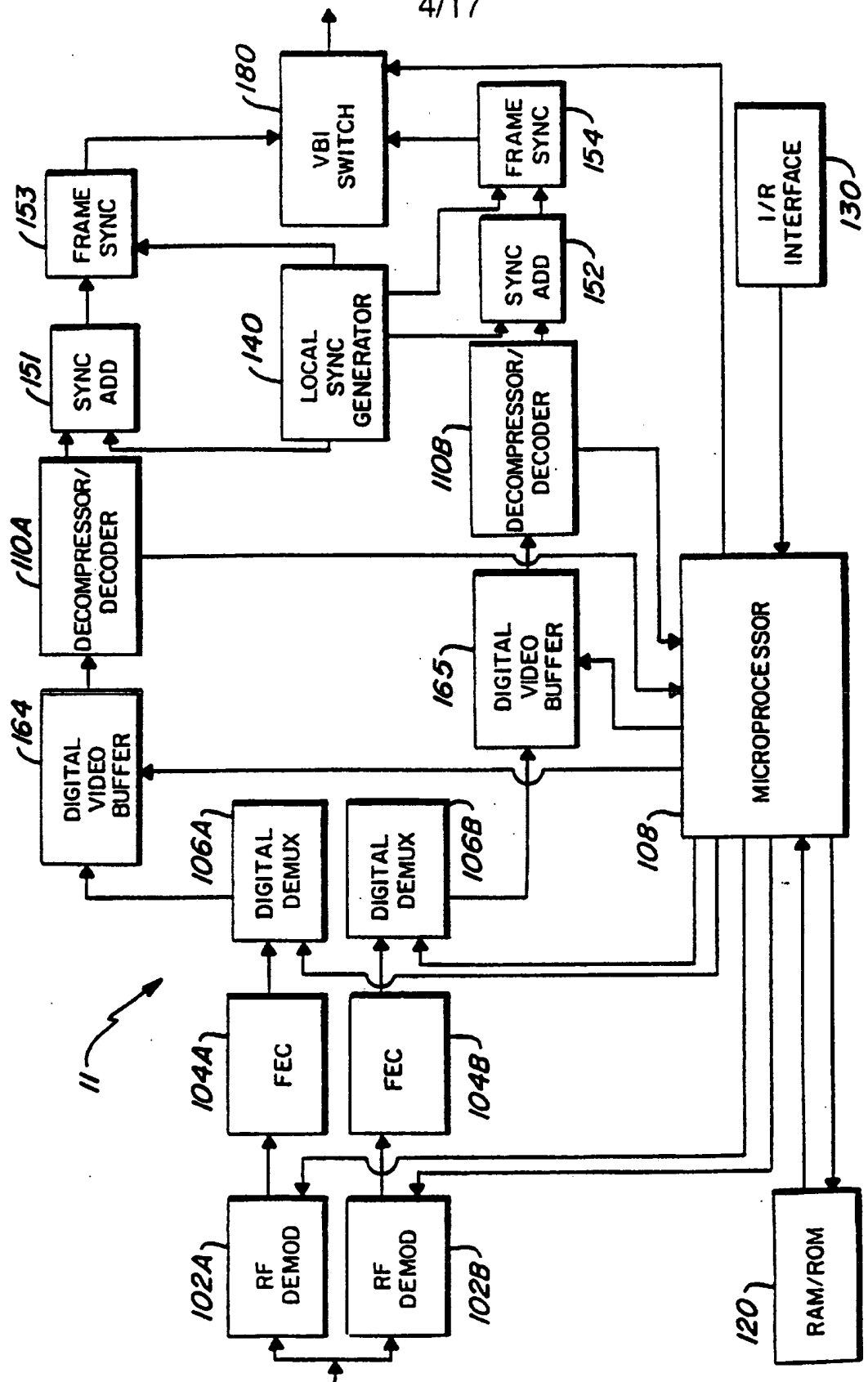


Fig. 4

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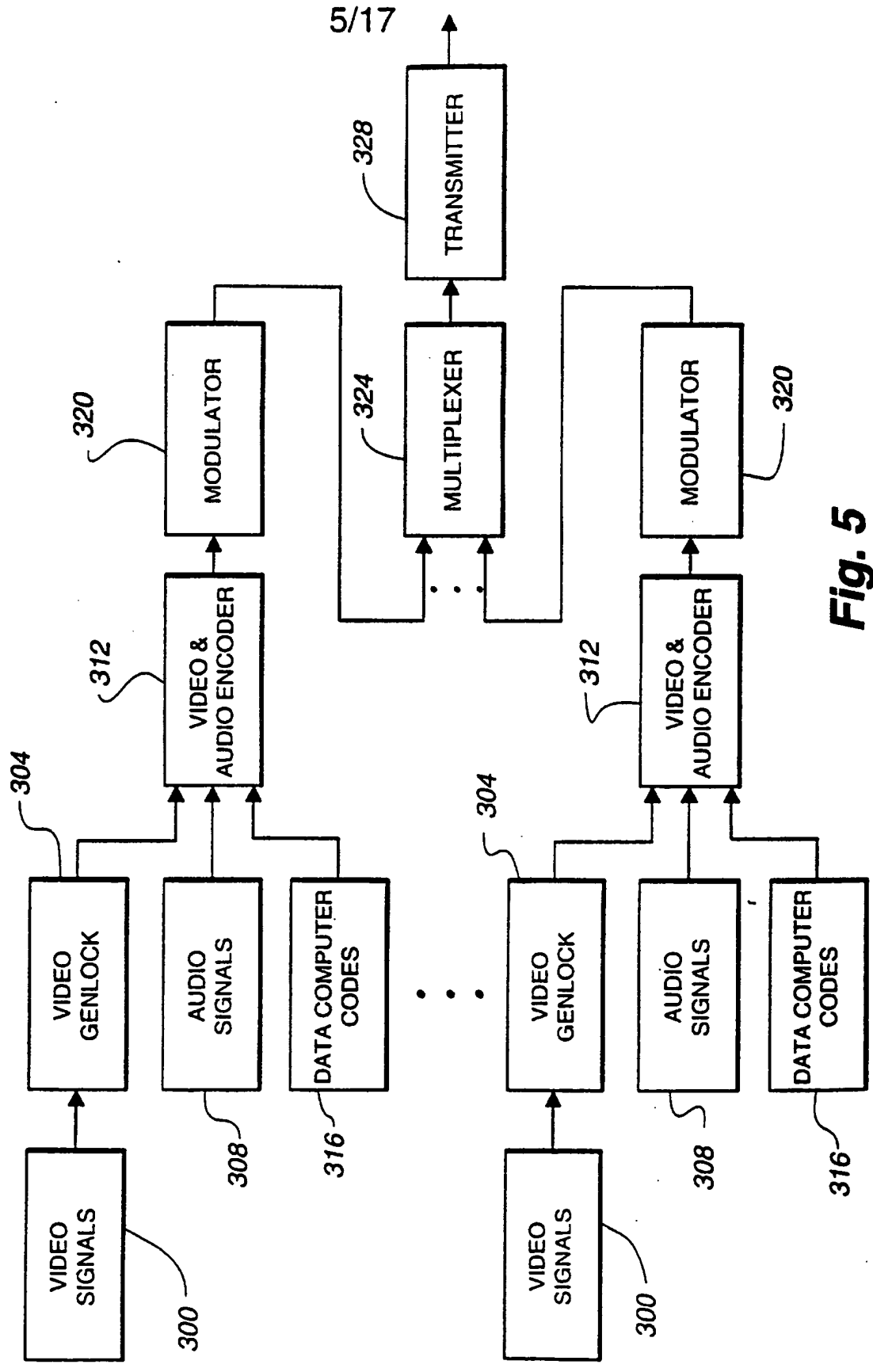


Fig. 5

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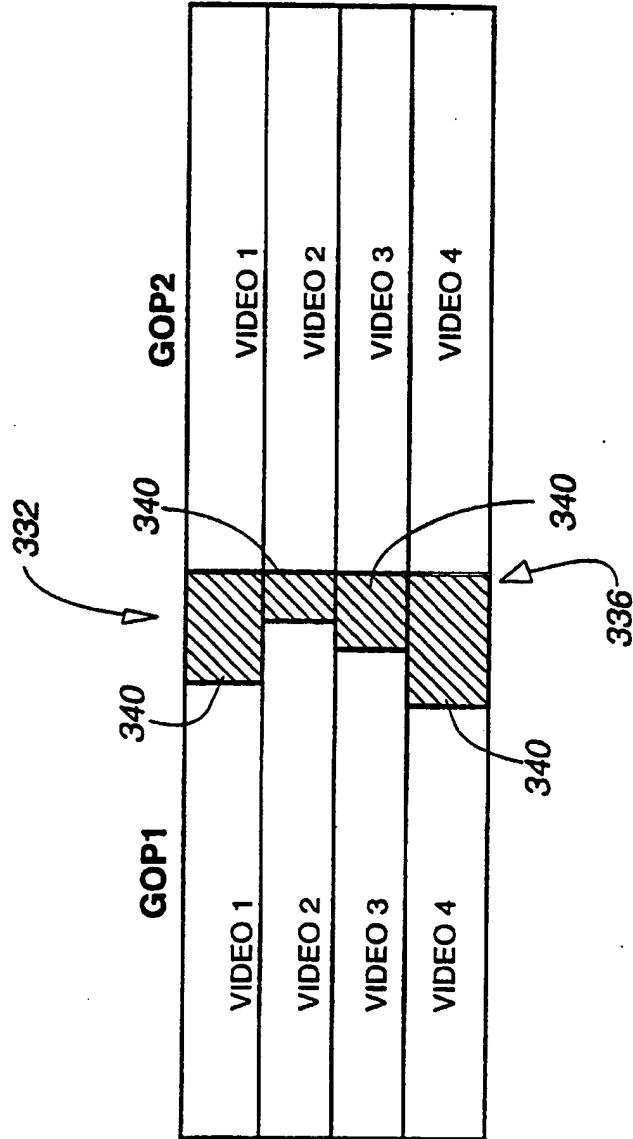


Fig. 6

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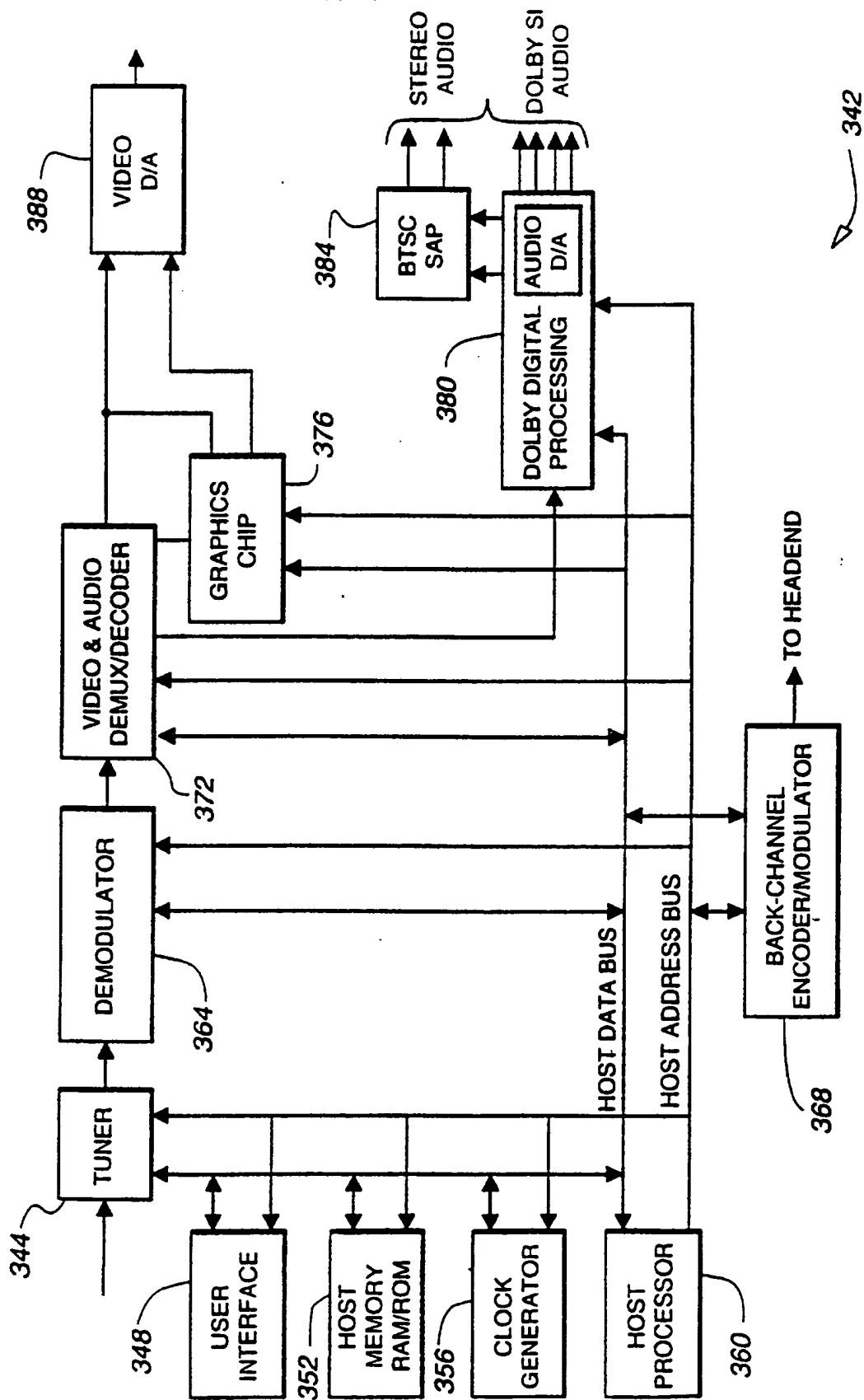


Fig. 7

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AUDIO 1	1	2	3	4	5	6	7	8	9	10
AUDIO 2	1	2	3	4	X	6	7	8	9	10
AUDIO 3	1	2	3	4	X	6	7	8	9	10
AUDIO 4	1	2	3	4	X	6	7	8	9	10

TRANSPORT PACKET
JITTER TIME

Fig. 8

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412

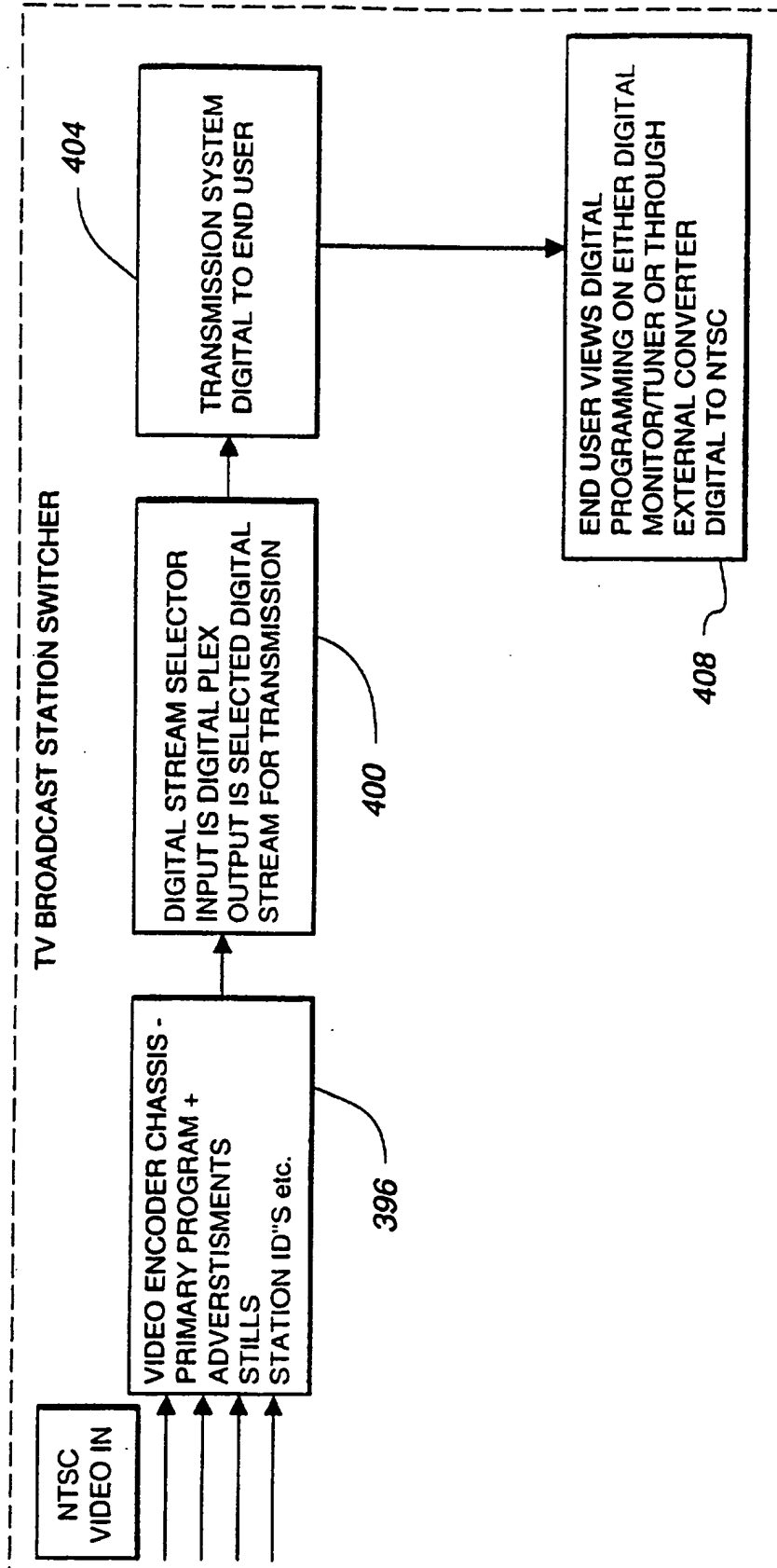


Fig. 9

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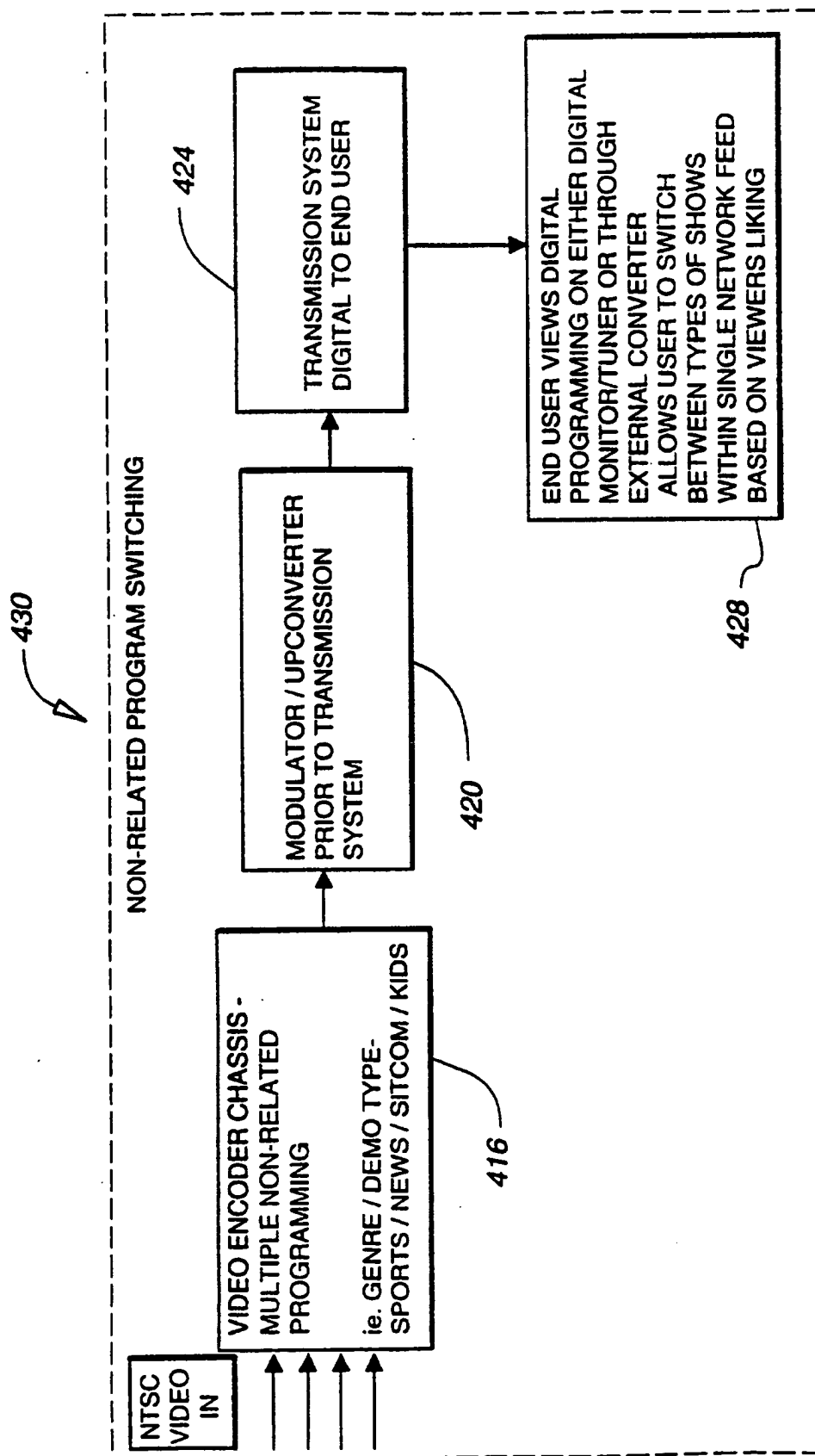


Fig. 10

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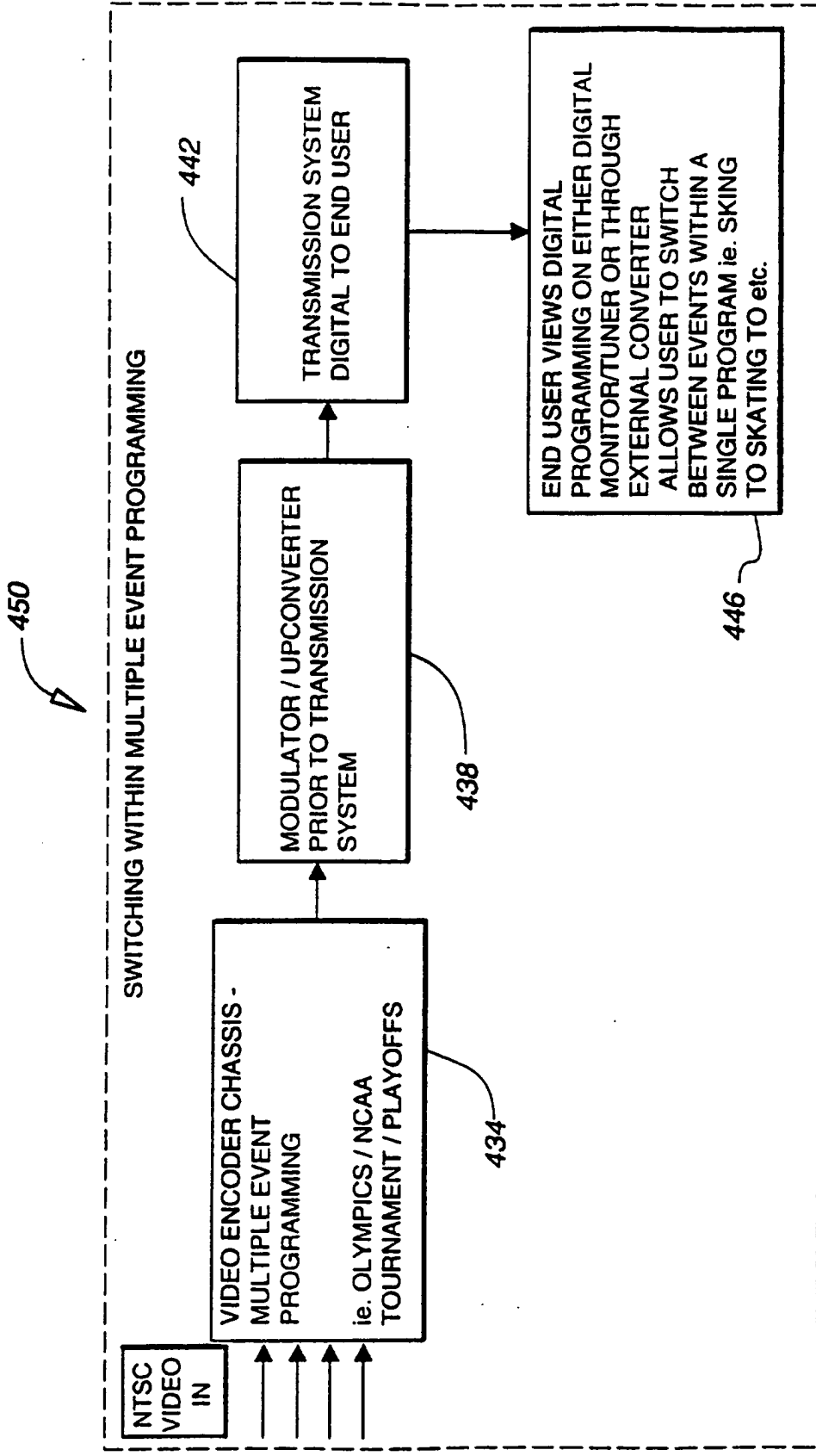
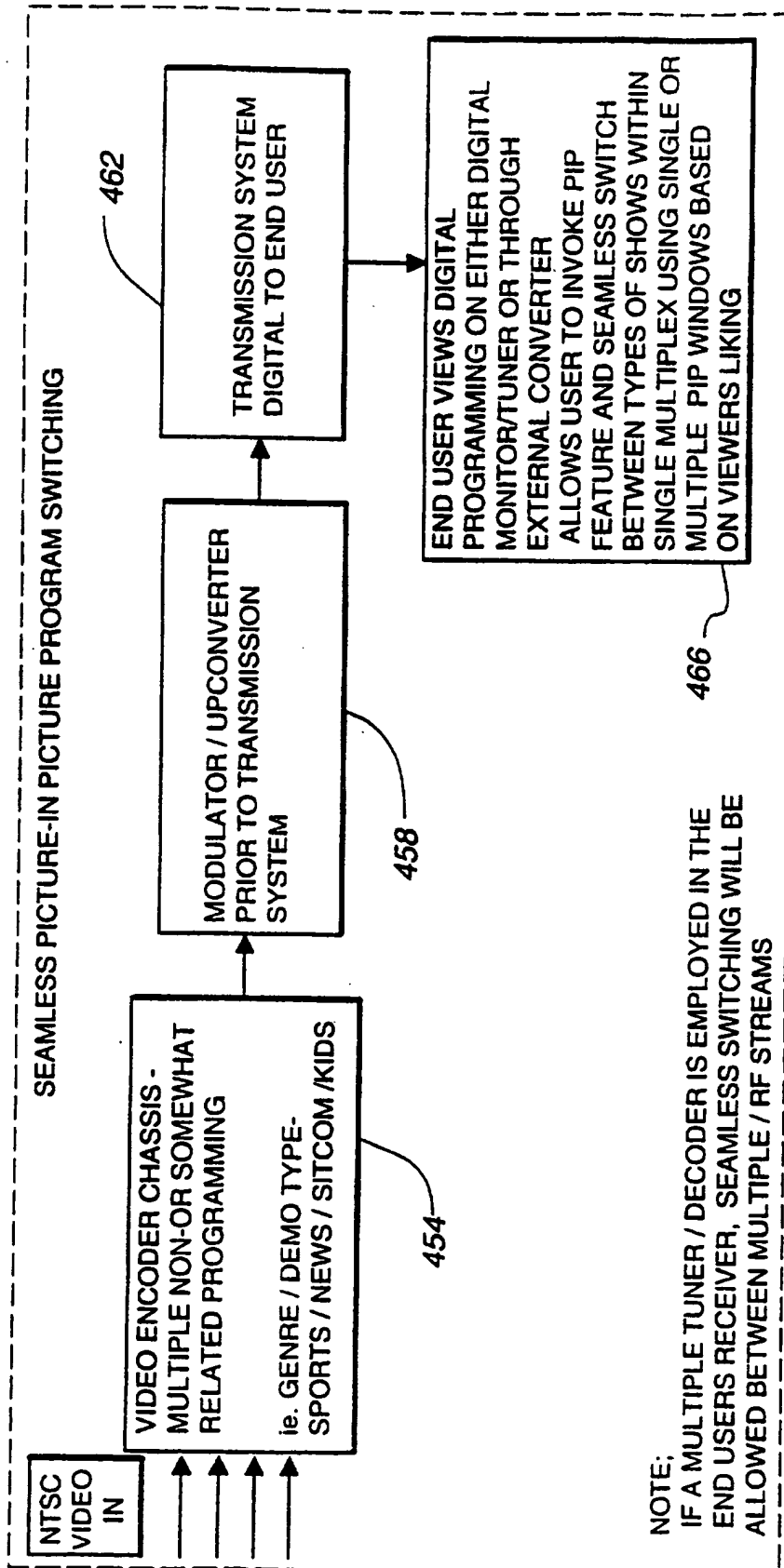


Fig. 11

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**Fig. 12**

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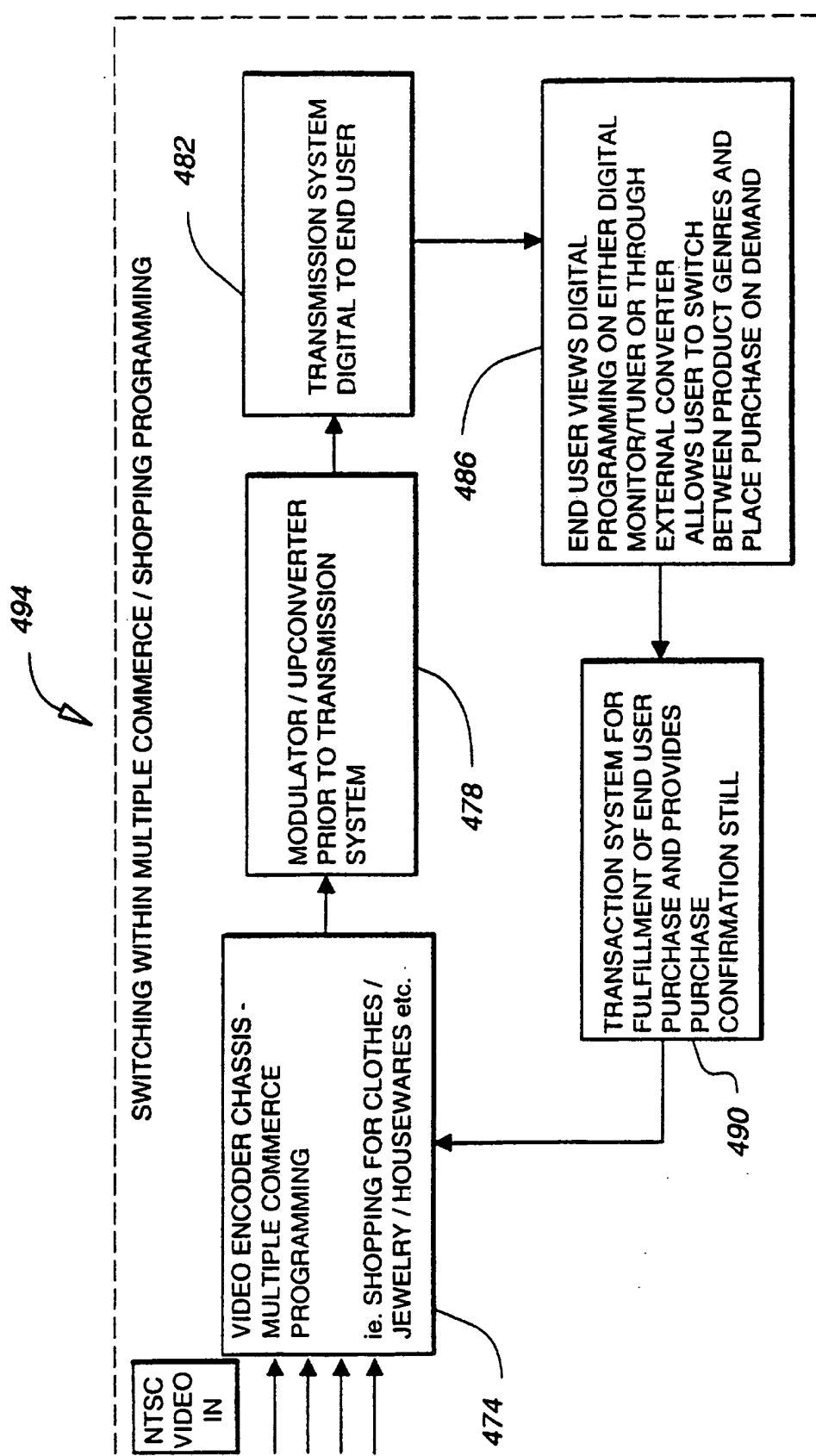
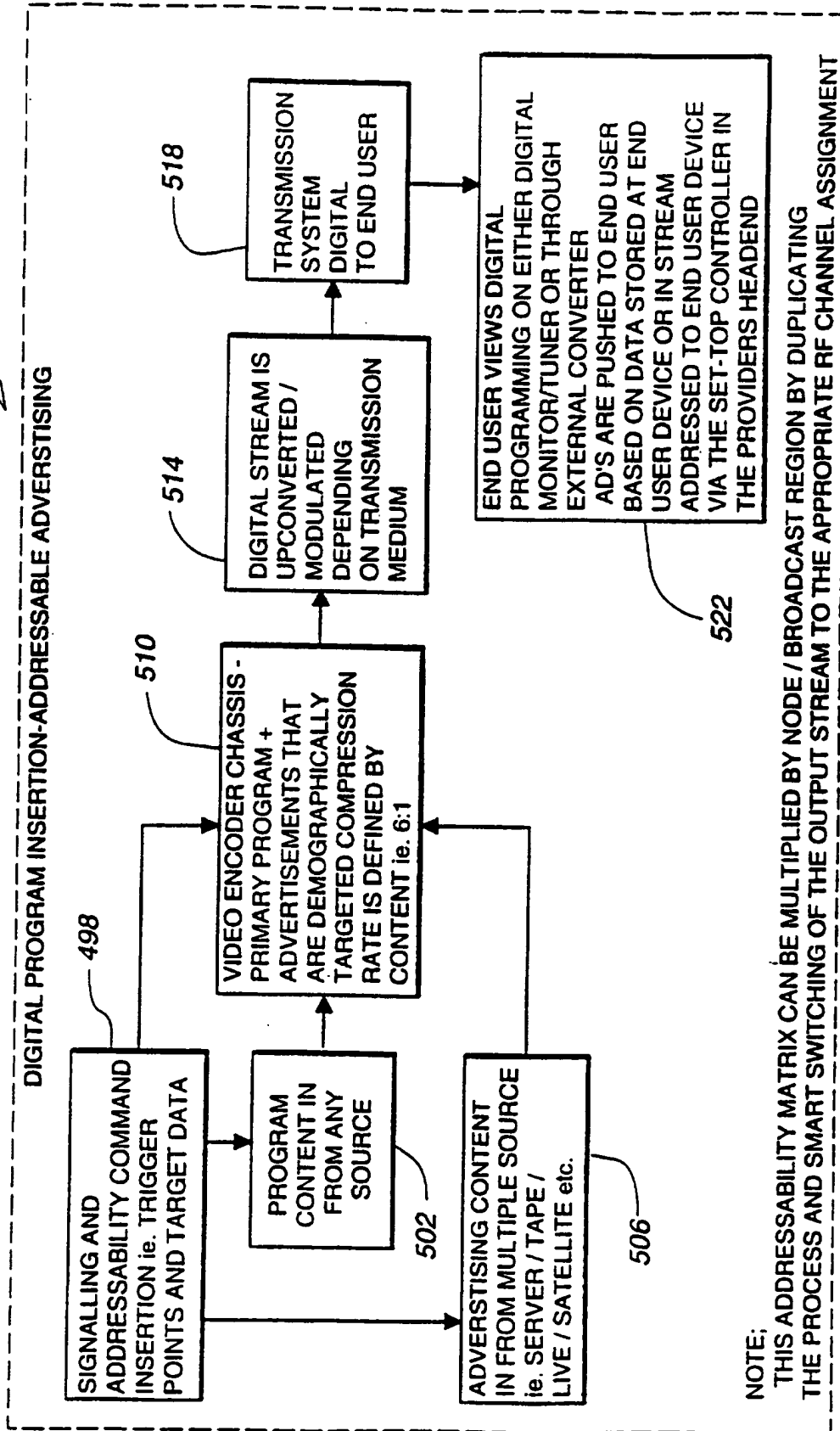


Fig. 13

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**Fig. 14**

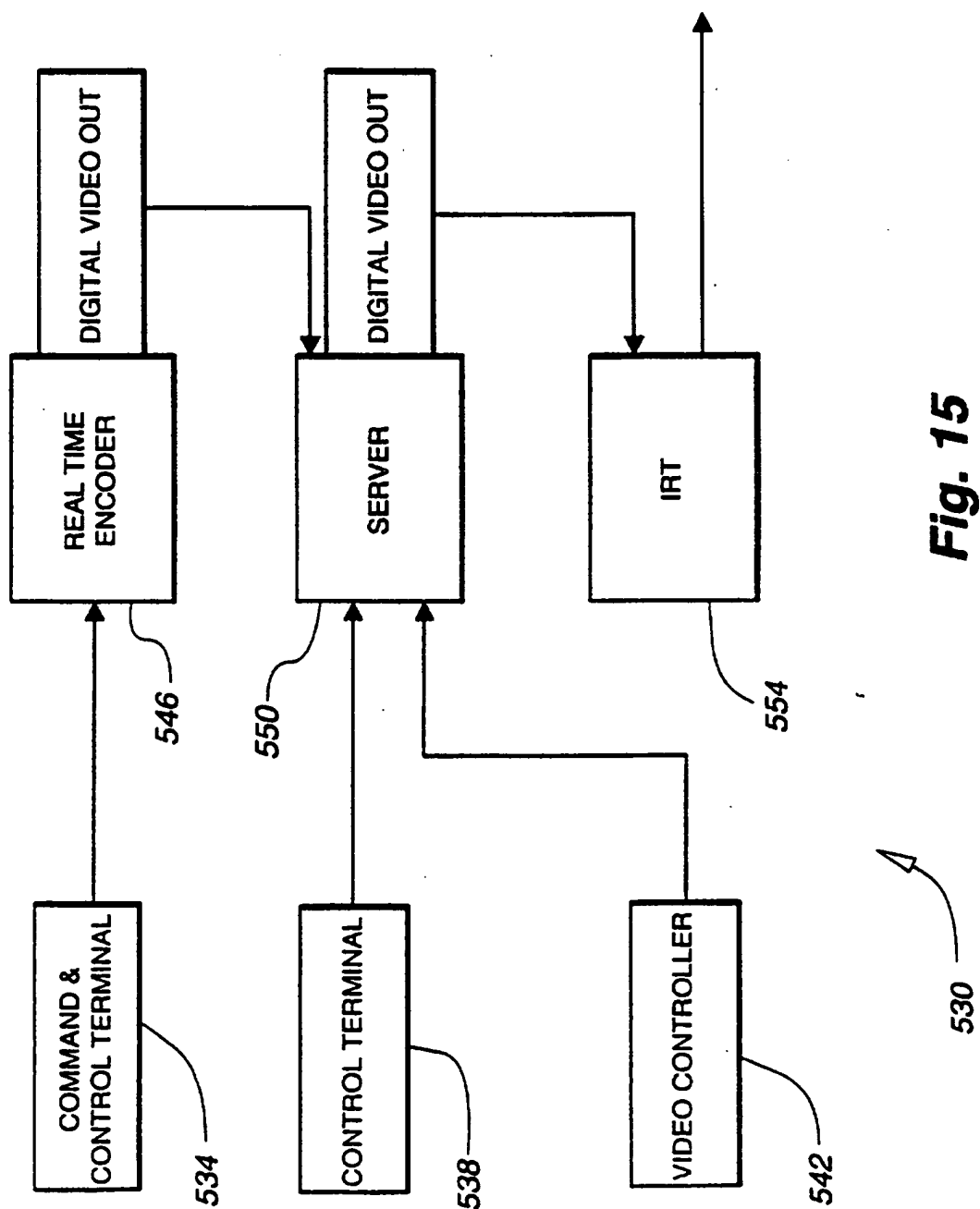


Fig. 15

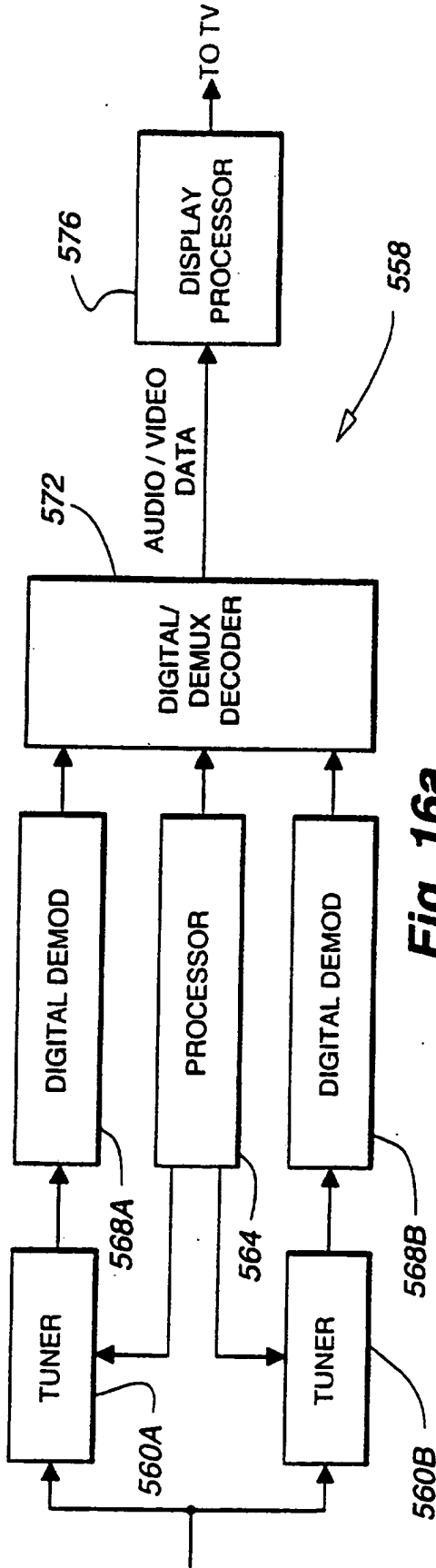


Fig. 16a

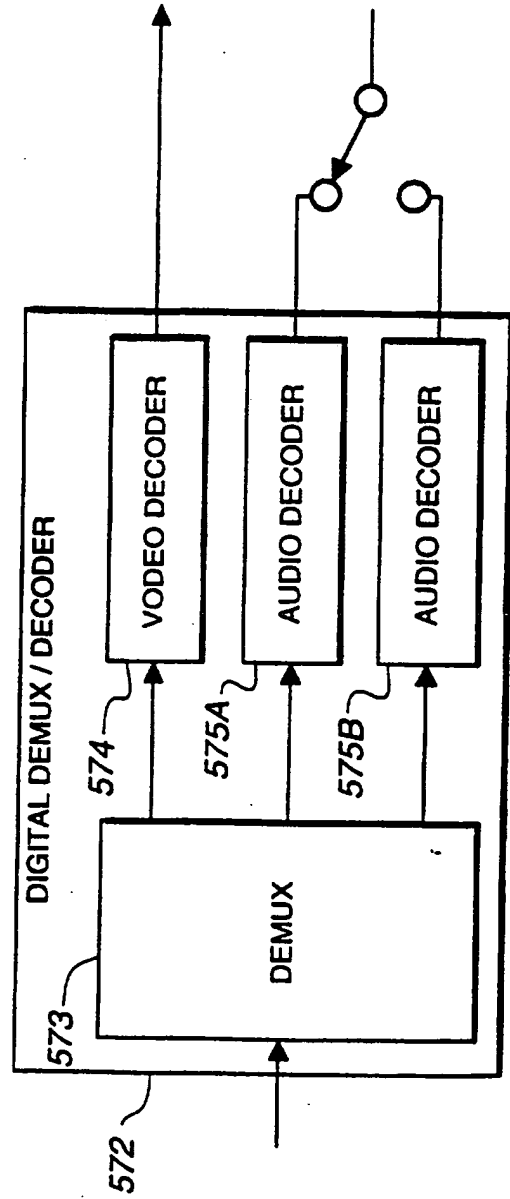


Fig. 16b

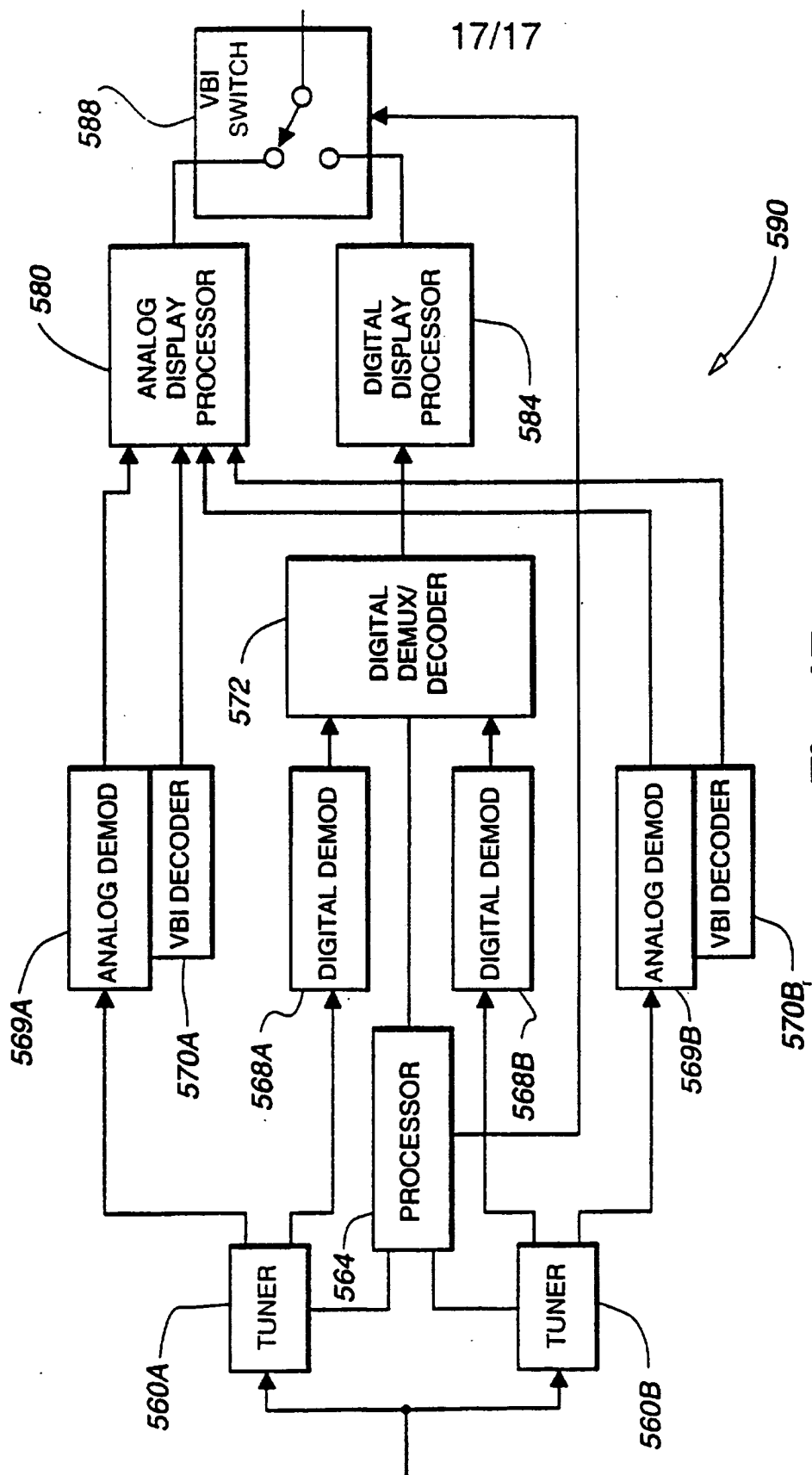


Fig. 17

A RECEPTION UNIT FOR PERFORMING SEAMLESS SWITCHES
BETWEEN VIDEO SIGNALS

5 The present invention relates to a unit for seamlessly switching
between video signals.

U.S. Patent No. 5,724,091 describes seamlessly switching between
video signals whilst viewing a first video signal, even though the video signal
switched to may be on a different broadcast channel, or on the same channel
10 multiplexed with, the currently viewed video signal.

The present invention seeks to provide a reception unit for seamlessly
switching between video signals which employs a less complex method.

15 According to a first aspect of the present invention, there is provided a
reception unit for receiving programming and capable of performing seamless
switches from either a first analog signal to a second analog signal, an analog
signal to a digital signal, or a first digital video signal to a second digital video
signal, comprising:

20 a microprocessor, for selecting one of the video signals and directing a
seamless switch to the selected video signal;

 a pair of tuners, connected to the microprocessor, for tuning to RF
channels, wherein the pair of tuners selects the RF channels on command
from the microprocessor;

25 a pair of analog demodulators, each analog demodulator connected to
one of the tuners, and capable of receiving one analog signal;

 a pair of digital demodulators, each digital demodulator connected to
one of the tuners, and capable of receiving one digital signal;

30 a digital demultiplexer/decoder, connected to the pair of digital
demodulators, for demultiplexing digital signals, decompressing the digital
signals, and for performing a seamless switch from one digital video signal to
another digital video signal;

a digital display processor, connected to the output of the digital demultiplexer/decoder, for converting the decompressed output digital signal to an analog signal; and

5 a vertical blanking interval switch, operably connected to the output of the digital demultiplexer/decoder and the output of the analog demodulator, for seamlessly switching between the analog video signals.

Preferably, a multiplexer combines the various digital signals into a reduced number of transmission data streams for transmission. The various
10 NTSC television channels may be allocated in a predetermined fashion to maximize the number of simultaneously transmittable signals. The multiplexer in conjunction with the television transmission system multiplexes the desired data streams onto the desired channels, and transmits these signals over the NTSC channels. The number of video signals which may be multiplexed onto
15 a data stream on a single transmission channel will vary depending on the video signals to be transmitted. The television channels containing a data stream of multiplexed video signals may be transmitted over a standard cable television distribution network, or direct broadcast satellite transmission system.

20

After encoding, compression, multiplexing and modulation, the program signals and interactive program signals are distributed by a transmission means including, but not limited to, satellite, cable television, fiber optics, public switched telephone network, terrestrial broadcast, closed circuit, etc.,
25 where the modulation technique is defined by the means of transport. Additionally, the distributed content may include a signal conversion or retransmission prior to receipt by the end users.

The programs are received at an end user's location and connected to
30 the appropriate reception device. Reception devices, for example, may include, but are not limited to, cable television receivers/converters, satellite receivers, terrestrial broadcast receivers, personal computers, etc. The

receiver receives one or more television channels, some or all containing a multiplexed data stream of video signals or non-multiplexed digital video signals, and in conjunction with a signal selector, selects a particular data channel/ data stream for playback, then selects a particular video signal from the data stream's multiplexed signal, and finally expands the video signal, if necessary, for playback to a television monitor.

The signal selector may comprise a controller and software, for example, in a digital set top box. The controller and software in a digital set top box operate to control the receiver and signal selector to select a particular digital video signal.

A user inputs responses preferably via a standard remote device. The user may be simply changing from one channel to another or providing responses to an interactive program.

The present invention also extends to a seamless switching unit for receiving programming and performing a seamless switch from a digital video signal multiplexed in a first program signal received in a first RF channel to an analog video signal multiplexed in a second program signal received in a second RF channel, comprising:

- a microprocessor, the microprocessor directing the switch from the digital video signal to the analog video signal;
- a first tuner, connected to the microprocessor, for tuning to the first RF channel;
- a digital demodulator, connected to the first tuner, for demodulating the first program signal;
- a digital demultiplexer/decoder, connected to the first digital demodulator and microprocessor, for demultiplexing the first program signal to obtain the digital video signal, and decompressing and decoding the digital signal;

a digital display processor, connected to the digital demultiplexer/decoder, for converting the digital video signal to analog;

a second tuner, connected to the microprocessor, the second tuner pre-tuning to the second RF channel;

5 an analog demodulator, connected to the second tuner, for receiving and demodulating the analog signal;

a vertical blanking interval switch, operably connected to the output of the digital demultiplexer/decoder and the output of the analog demodulator, for seamlessly switching from the converted digital video signal to the analog
10 video signal during the vertical blanking interval of the signals.

Embodiments of the present invention will hereinafter be described, by way of example, with reference to the accompanying drawings, in which:-

15 FIGURE 1 is a block diagram of an interactive television system,
FIGURE 2 is a block diagram of an interactive television system in a two-way transmission configuration,

FIGURE 3 is a block diagram of one embodiment of a receiver to achieve seamless switching between video signals,

20 FIGURE 4 is a block diagram showing an alternative embodiment of a receiver to achieve seamless switching between video signals,

FIGURE 5 is a block diagram of an embodiment of a central controller,

FIGURE 6 is a block diagram showing a video frame structure and illustrating video splice points and time gaps in the video programming
25 streams,

FIGURE 7 is a block diagram of an alternative embodiment of a receiver,

FIGURE 8 is a block diagram showing audio frames,

FIGURE 9 is a block diagram of a TV broadcast station switcher,

30 FIGURE 10 is a block diagram of an embodiment of a controller for non-related program switching,

FIGURE 11 is a block diagram of an embodiment of a controller for switching within multiple event programming,

FIGURE 12 is a block diagram of an embodiment of a controller for seamless picture-in-picture program switching,

5 FIGURE 13 is a block diagram of an embodiment for switching within multiple commerce shopping programming,

FIGURE 14 is a block diagram of an embodiment for digital program insertion – addressable advertising,

10 FIGURE 15 is a block diagram of an embodiment for seamless switching from a group of signals to other signals at a server,

FIGURES 16A and 16B are block diagrams of an alternative two-tuner embodiment, and

FIGURE 17 is a block diagram of an alternative two-tuner embodiment.

15 An interactive television system as described herein enables a plurality of viewers to be simultaneously provided with a plurality of different program information message signals. A plurality of video signals 1 are provided. The video signals 1 may be, for example, various field and/or audio synchronized camera angles of a sporting event, or a game show having a content and host
20 acting responsively to user selections. Alternatively, the video signals 1 may be any video signals suitable for interactive conversation such as those described in U.S. Patents Nos. 4,847,700, 3,947,972, 4,602,279, 4,264,925, or 4,264,924. Various types of time and content related video signals exist which are suitable for interactive operation.

25

 In previous systems, these various signals would be transmitted to a receiver on separate broadcast or cable channels each requiring a separate 6 MHZ NTSC channel. In a system as shown in Figure 1, the video signals 1 are directed to analog-to-digital ("A/D") convertors 2 which convert the various
30 video signals into digital format for transmission. The A/D convertors 2 may be of any conventional type for converting analog signals to digital format. An A/D convertor may not be needed for each video signal 1, but rather fewer

convertors, or even a single convertor are capable of digitizing various video signals 1. Interactive video programs may also be delivered to a cable or other distribution network in pre-digitized and/or precompressed format.

5 Digital conversion results in very large amounts of data. It may therefore be desirable to reduce the amount of data to be sent, allowing more signals to be sent over a single transmission channel. For example, a single frame of digitized NTSC video represents over 350 Kbytes of data. Therefore, two hours of standard video is about 80 Gbytes. Since there are 30
10 frames/sec in such video the data transfer rate is 22 Mbytes/sec. This large amount of data is preferably reduced by digital compression.

 In order to reduce the data transfer requirements, the various digital video signals are preferably compressed before transmission. The video may
15 be compressed by any conventional compression algorithm, the two most common types being "processor intensive" and "memory intensive".

 The processor intensive approach performs compression by eliminating non-changing aspects of a picture from the processing in the frame-to-frame
20 transfer of information, and through other manipulations of picture information involving mathematical computations that determine the degree to which a given motion in a picture is perceptible to the human eye. This approach depends on high-speed processing power at the transmission point.

25 The memory approach involves division of a picture frame into hundreds of minuscule blocks of pixels, where each block is given a code representing its set of colors and variations in luminance. The code, which is a much smaller increment of information than all the information that would describe a given block of the picture, is transmitted to the receiver. There, it
30 calls up the identically coded block from a library of blocks stored in the memory of the receiver.

Thus, the bit stream represents a much smaller portion of the picture information in this approach. This system is generally limited by the variety of picture blocks which may be stored in the receiver, which relates directly to memory size and microprocessor power.

5

Examples of commonly known compression techniques which may be used are JPEG, MPEG1 and MPEG2.

Data compressors 3 are provided to reduce the data for each video
10 signal which must be transmitted. The data compressors 3 may be of any
suitable type for compressing video images, such as those previously
described. Compression of the various video signals might be done with fewer
data compressors 3 than one compressor per video signal. In a conventional
analog NTSC system, by way of example, it is customary to transmit one video
15 signal per 6 MHZ channel. By digitizing the video signal, it is possible to send
a data stream containing more than one video signal in one channel.
Compressing the digitized signals, allows even more video signals to be
transmitted over a single transmission channel. The number of signals which
may be sent over a single channel is generally related to, for example, a) the
20 type of video being sent; b) the video compression scheme in use; c) the
processor used and memory power; and d) the bandwidth of the transmission
channel.

Compression techniques exploit the fact that in moving images there is
25 very little change from frame-to-frame. Editing out the redundancies between
frames and coding just the changes allows much higher compression rates.
The type of video which normally contains a great deal of high-speed
movement, such as occurs at live sporting events, will, therefore, have the
lowest compression rates. Movies, on the other hand, which normally have a
30 lower frame rate and less frame-to-frame change than a live sporting event will
achieve higher compression rates. Currently, commonly known compression

schemes have compression rates that vary from 2:1 to 10:1 for satellites, and 2:1 to 5:1 for cable television systems, depending on the degree of motion.

One the various video signals 1 have been digitized and compressed, a
5 multiplexer 4 combines the various digital signals into a reduced number of transmission data streams for transmission. For example, if 68 NTSC channels are available, and each channel is capable of transmitting either 4 digitized, compressed slow moving video signals (e.g. movies) or 2 digitized, compressed, high-speed video signals (e.g. sports), then the various NTSC
10 channels should be allocated in a predetermined fashion to maximize the number of simultaneously transmittable signals.

As an example, the broadcast frequency corresponding to a first NTSC channel may contain a data stream of separate digitally compressed non-
15 interactive movies. On this frequency, the data stream would contain video signals representing a number of movies. However, the video signals, unlike those of an interactive program are not related in time and content. The frequency corresponding to a second channel might contain a digital data stream of an interactive sports program consisting of two multiplexed
20 compressed high-speed video signals that are preferably related in time and content. The frequency corresponding to a third channel might contain a digital data stream of an interactive movie consisting of four multiplexed compressed video signals which are related in time and content. The frequency corresponding to a fourth channel might contain an analog NTSC
25 signal relating to local programming. Therefore, four NTSC channels could contain a channel of multiplexed movies, an interactive sports program, an interactive movie, and local programming.

Multiplexer 4 receives the incoming compressed, digitized video signals
30 and in a predetermined known fashion, in conjunction with transmitter 5, multiplexes the desired video signal onto the desired channels, and transmits

these signals over the NTSC channels. Certain NTSC channels may contain only one video or other signal, in analog or digital form.

As indicated earlier, the number of video signals which may be multiplexed onto a data stream on a single transmission channel will vary. Also, the number of channels which use data streams may vary. The transmission data streams are transmitted by transmitter 4 via transmission media 6 to a receiving station 7. The transmitter 4, media 6, and receiver 7 may be any conventional means for transmitting digital video signals including broadcast television, cable television, direct broadcast satellite, fiber optic, or any other transmission means. Alternatively, a self-contained, stand-alone system may be provided, as explained below.

The transmission means may also be a telephone system transmitting a digital video data stream. Thus a multiplexed data stream containing several broadcast channels or an interactive program with related video signals may be sent directly to a user over a single telephone line. The aforementioned digital transmission devices may include means for transmitting analog signals as well.

20

In one embodiment, the digital transmission signal is transmitted using a cable television system. Receiver 7 receives various NTSC channels, some or all containing multiplexed or non-multiplexed digital video signals. Ordinarily, more than one channel will be transmitted by transmitter 5 and received by receiver 7 as in an ordinary cable television system. However, each of the different channels may have a data stream containing several digitized video signals thereon.

Therefore, receiver 7 preferably operates in conjunction with signal selector 8 to select a particular NTSC channel for playback, then to select a particular video signal from the data stream's multiplexed signal, and finally to

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uncompress or expand the compressed video signal, if necessary for playback to monitor 10.

Multiple choice controller 9 operates to control receiver 7 and signal selector 8 to select a particular video signal for playback. In practice, a user need not know that multiple signals per channel are in use. If, for example, 68 channels with 4 signals-per-channel were in use, controller 9, in conjunction with receiver 7 and signal selector 8 might be programmed to represent these channels to the user as channels 1-2-72. Monitor 10 may be, for example, a conventional television. Signal selector 8 preferably includes a conventional de-multiplexer for selecting a particular video signal from the data stream on the channel currently being received by receiver 7. Signal selector 8 further includes the necessary un-compression or expansion apparatus corresponding with the compression scheme in use by compressors 3.

15

In practice, an interactive sporting event program might be transmitted on a 6 MHZ cable television signal using a compression-multiplexing scheme which allows two sports video signals (A and B, for example) to be transmitted over a single NTSC channel (channel 34, for example). It might be desired to have four video signals (A-D, for example) for the particular interactive sporting event. A first video signal (signal A) may contain the standard broadcast signal of the game; the second video signal (signal B) may contain a close-up view of the game action; a third video signal (signal C) may contain a continuously updated replay of game highlights; the fourth video signal (signal D) may contain statistical information. These four video signals (A-D) may, for example, be multiplexed as follows: video signals A and B multiplexed onto a data stream transmitted on cable channel 34; video signals C and D multiplexed onto a data stream transmitted on cable channel 35. Alternatively, all four video signals (A-D) could be multiplexed into one data stream carried on one frequency channel. These four signals may, however, be mapped by controller 9, or signal selector 8, to play as separate channel displays for the user which, when the viewer makes choices on the multiple

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choice controller, a seamless switch occurs therebetween. Each video signal of this interactive program may include a label which reads, for example, "Full-Screen Action – Press A: Close up Action – Press B: Replay – Press C: Statistics – Press D".

5

As shown, if more signals were needed for an interactive program than were mappable to a data stream on a single channel, signal selector 8 in conjunction with receiver 7 may be programmed to switch between the various video signals 1 as well as the various broadcast channels to provide the necessary level of interactivity. However, preferably all the various video signals associated with a particular interactive program are multiplexed onto a single channel.

Additionally, the signal selector 8 may store information relating to current and previous user responses. For example, the personal profile of the viewer or previous response patterns of the viewer could be stored in memory. This information may be used in conjunction with commands transmitted within the video signals, as discussed in U.S. Patent No. 4,602,279. The second personal profile information and received commands may be used to switch interactively between data streams and video signals without any additional response from the user.

The multiplexed interactive program may be transmitted over a single telephone line, if desired. In this embodiment, multiple choice controller 9 is programmed to switch between the various video signals on the single telephone line. If additional channels were desired, a two-way configuration is used as described below.

The interactive television system may be utilized in an educational embodiment in which, for example, information is stored on each data stream in a plurality of reproducible information segments, each of which comprises a complete message reproducible by the receiver directly in response to the

selection of the video signal by signal selector 8 responsive to a user selection on multiple choice controller 9. Each of the information segments in the various data streams contain interrogatory messages with associated multiple choice responses, responsive messages, informational messages, or
5 combinations thereof.

The various information segments in the various data streams preferably relate in real-time and content so that an interactive conversation may occur as the video signals are displayed and the user responds to the
10 various interrogatories contained in the video signals. As a user answers a particular interrogatory with a multiple choice response, the information in the video signal associated with the particular selection is displayed by the signal selector 7. The various interrogatories, responsive messages, and
15 informational messages may generally be contained in any one, more than one or all of the various video signals.

The use of a data stream containing multiple video signals per broadcast channel may be used for many types of interactive programs, for example, such as those described in the previously mentioned U.S. patents, or
20 in other interactive programs which may be developed.

As indicated above, a stand-alone system with no transmission means necessary may be provided. In this case, the digitized video signals that make up an interactive program are stored in local storage means such as video
25 tape, video disk, memory (e.g. RAM, ROM, EPROM, etc) or in a computer. Preferably, the digital video signals are multiplexed onto a standard NTSC signal. The particular storage means may be connected to any of the interactive boxes described with reference to Figures 3 to 5. The interactive boxes would then be connected to a television set. Alternatively, the circuitry
30 in Figures 3 to 5 could be implemented on a board and inserted into a standard personal computer (PC). A separate microprocessor on the interactive board is not necessary for this configuration since the standard PC

processor performs the functions of the processor 108, shown in Figures 3 to 5.

As shown in FIG 2, an interactive television system may be operated in a two-way configuration. In this mode, the various video signals 1 are processed as previously described, being digitized by A/D convertors 2 and compressed by video compressors 3. This signals are then routed to a central switching station 14. In this embodiment, the switching between the various video signals is accomplished at the head end rather than at the receiver.

Multiple choice control unit 9 relays the multiple choice selections of the user through a relay box 17 back to the remotely located switching station 14. The multiple choice selections may be relayed by relay box 17 to the switching station by any conventional means, such as two-way cable television, telephone, or FM transmission. Switching station 14 receives the multiple choice selection of the user and routes the desired signal to transmitter 5 which conventionally transmits the desired video signal down the appropriate cable channel for the particular user. If desired, transmitter 5 may also transfer conventional programming on the cable television channels not being used for interactive programming. Alternatively, switching station 4 may include multiplexing equipment as previously described, and thus operate multiple interactive or noninteractive programs over a single television channel.

For example, if it were desired to implement an interactive football game program, a single NTSC cable channel may be allocated for the program. However, in this instance, the video signals would be present at the transmitting end. In response to a signal from wireless controller 9, a signal is sent by relay box 7 to the cable TV switching station which routes the desired video signal to the requesting viewer. Such a system requires very fast switching equipment, but can be implemented using digital imagery.

Alternatively, it may be desirable to transmit the interactive sporting event over a single telephone line. When the user enters a selection on controller 9, a signal is sent via the telephone line to the central switching station which routes the desired signal of the interactive program over the user's telephone line so that a single link handles both the interactive choice being made at the receiver and the transmission of that choice, out of a plurality of choices, from the head end where the actual switching takes place in response to the interactive selection made at the receiver.

The two-way link between the user and the switching station may be used for other purposes. For example, demographic data may be transferred from the user to the broadcast network for commercial purposes, such as targeted advertising, billing, sending a game show winner a winning number for pickup of a prize, or other commercial or non-commercial purposes.

As previously described, compression systems generally perform less efficiently when frame-to-frame content includes many changes in pixel content (e.g., during fast motion or scenery changes). The system may advantageously be programmed to ease the processing burden on the uncompression program. When a key on the controller is depressed to select a desired signal, a slight imperceptible delay may be effectuated if desired. This delay allows the uncompression or expansion algorithm a short period of time to adjust to the rapid change from one video signal to another which ordinarily causes a degradation in the efficiency of the algorithm causing video glitches to appear on the screen display.

Figures 3, 4, 7, 16 and 17 show preferred embodiments of a receiver 7 of a signal selector 8 to enable seamless flicker-free transparent switching between the digital video signals on the same channel or different channels. These embodiments may be connected to any transmission media or simply connected to the output of any stand-alone storage means for the digitized multiplexed interactive program. Preferably, the receiver 7 and signal selector

8 are both components of an interactive program box 11, which connects to a television or other display monitor. Alternatively, the required functionality of the RF receiver 7, signal selector 8 and monitor could all be combined in a standard personal computer by the addition of a few components to the personal computer. To provide this capability, only an RF demodulator board, digital demultiplexer, decompressor(s), frame buffer(s), and sync components need to be added to the personal computer. These items, and any other components, may be connected to the PC processor and storage elements as disclosed in Figures 3, 4, 7, 16 and 17. In this embodiment, the user makes selections via the computer keyboard.

Figure 3 shows an embodiment with a single analog frame buffer. Figure 4 includes pairs of RF demodulators, error correctors, and demultiplexers and/or a pair of digital video buffers, as described below.

Figure 3 shows an embodiment of a receiver which allows for a seamless video switch between two or more separate digital video signals. As shown in Figure 3, a microprocessor 108 is connected to RF demodulator 102 and digital demultiplexer 106. The microprocessor 108 directs demodulation and demultiplexing of the proper channel and data stream to obtain the correct video signal. The proper channel is determined either by examination of the user's input from user interface 130 and/or any other information or criteria (such as personal profile information) stored in RAM/ROM 120. For example, the RAM/ROM 120 could store commands provided within the video signals as described in U.S. Patent No. 4,602,279. The user interface 130 may be an infrared, wireless, or wired receiver that receives information from multiple choice control unit 9.

The RF demodulator 102 is part of the receiver 7, and demodulates data from the broadcast channel directed by the microprocessor 108. After the data stream is demodulated, it passes through a forward error correction circuit 104 into a digital demultiplexer 106. The demultiplexer 106 is controlled

by microprocessor 108 to provide specific video, audio and data signal out of a number of video, audio and data signals located within the data stream and steer them to the appropriate device for use within the system. In order to seamless splice from one video stream to the other it is preferred to perform
5 the switch in the digitally compressed domain thereby eliminating the need to decode two video audio and data streams at the same time.

When the compressed digital video is sent to the video decode function it is first stored in memory 160 until there is enough information buffered to
10 ensure continuous playback of the video stream. Because of the compressed nature of the video information, a relatively small buffer 160 can hold a significant amount of video information (on the average of five to six frames). This means that there is a significant delay from the time the compressed video is received to the time it is decompressed and played out. Therefore,
15 the preferred method for switching in the set top would be to select the new video on the way into the video buffer 160 while continuing to play out the old video to the monitor. Because the incoming stream has been created by producing syntactically correct MPEG segments that are sliceable, this can be achieved easily. By this method there is no need for additional hardware in
20 the receiver. A video always appears to the viewer to be a single video stream with no repeated or dropped frames.

MPEG allows for the reconstruction of the video clock at the receiver 11 through use of a data field called the PCR (Program Clock Reference). This is
25 necessary to ensure that the decoder can play out the decoded video at the same rate as it was input to avoid dropping or repeating frames. Additional embedded information in the MPEG stream includes the PTS (presentation time stamp) and DTS Display Time Stamp. These signals are used to maintain lip synchronization with the audio and also to inform the receiver
30 when to present the video and audio to the display.

Figure 4 shows an alternate, dual tuner embodiment for seamless switching between separate video signals. In this embodiment, the microprocessor 108 controls the selection of the RF channel that is demodulated by RF demodulators 102A, 102B. The demodulated data streams enter the forward error correctors 104A, 104B. At the output of the forward error correctors, the data streams are transmitted to the input of the digital demultiplexers 106A, 106B.

As with the RF demodulators 102A, 102B, the digital demultiplexers 106A, 106B are controlled by the microprocessor 108. This configuration allows the microprocessor 108 to independently select two different individual time-multiplexed video signals on different channels and data streams. If all the video signals of an interactive program were contained on a single channel or data stream, it would only be necessary to have a single RF demodulator, forward error corrector, and digital demultiplexer serially connected and feeding into the two digital video buffers.

Two data streams are provided from the digital demultiplexers 106A and 106B. The output of the demultiplexers contain a multiplicity of video, audio and data that can now be directed to the appropriate device under microprocessor 108 control. In this way it is no longer necessary to have all of the information contained in one RF channel. Instead the information can be found at different frequencies in the RF spectrum and it will still be possible to splice among the streams. By placing a simple digital switch at the output of the two demultiplexers, duplication of the entire decode chain can be avoided. It should be noted that this is only a cost saving approach and duplication of the rest of the chain would work as well.

A standard MPEG stream contains different types of encoded frames. There are I frames (Intracoded), P frames (Predicated) and B frames (Bi-directionally predicated). A standard MPEG structure is known as a GOP (group of pictures). GOPs usually start with I frames and can end with P or B

frames. There is generally only one I frame per GOP, but many P and B frames. While it is not necessary to have any I frames, they are useful for many reasons.

5 GOP's that end with B frames are considered open. GOP's that end with P frames are considered closed. For the present system, the GOPs are preferably closed to ensure that there are no motion vectors pointing to frames that are outside of the current GOP.

10 MPEG also reorders the video frames from their original display order during the encode process in order to code the video more efficiently. This reorder must be undone in the decoder in order for the video to present properly.

Frame Order	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Frame Type	I	B	B	P	B	B	P	B	B	P	I	B	B	P	B	B	P	B	B	P
Typical Frame Reorder	1	4	2	3	7	5	6	10	8	9	11	14	12	13	17	15	16	20	18	19
Transmission Order																				
Frame Type	I	P	B	B	P	B	B	P	B	B	I	P	B	B	P	B	B	P	B	B

15

GOP1

GOP2

Splices occur at the end of the B frame at the end of GOP1 prior to the I frame of GOP2. It is important to point out that with appropriate controls the encoder can code with variable GOP length and place splice frames accurately to achieve the desired interactive effect. If the content is unrelated then the encoder can splice at the end of every GOP allowing for a multiplicity of switching opportunities. Because the GOP ends in a P frame, a closed GOP is yielded.

25

Improved Seamless Switching in a Digital System

Any of the above-described reception unit embodiments can be used to handle seamless switching. However, seamless video switching at the reception units may be enhanced by modifying the encoding process.

5

Seamless switching between digital video signals, whether representing independent television programs or different related signals within one interactive program, is critical to the viewing experience. Seamless switching is defined as video stream switching that does not produce visible artifacts.

10 The effect of the encoding process is to simplify and enhance the seamless switching process.

The encoding process is performed at a central location, the elements of which are shown in Figure 5. As seen in Figure 5, a plurality of video
15 signals 300 are shown which could comprise live or prerecorded video streams. The origin of the video signals could be from cameras for live video, video servers, video tape decks, DVD, satellite feed, etc. The video signals can be in MPEG format, HDTV, PAL, etc. A plurality of audio signals 308 may originate from CD, tape, microphones, etc.

20

The data codes, shown emanating from the data code computer 316 in Figure 5, are the interactive commands for interactive processing used by the set top converter, as discussed above. Preferably, the data codes are part of an interactive scripting language, such as the ACTV scripting language,
25 originating in a coding computer 316. The data codes are also forwarded to the encoder 312. These data codes facilitate the multiple interactive programming options at the reception units. This embodiment requires a data channel for enabling a synchronous switch between a first video stream and a second video stream. This data channel comprises the codes which link
30 together the different program elements and information segments on the different video signals.

Referring again to the video signals 300, the plurality of video signals 300 are genlocked in the video genlock device 304 and thus, time synchronized. The time synchronized video signals are directed into the video and audio encoder 312. In the preferred embodiment, compatible encoders 5 312 are required at the cable headend to work with the digital reception units at the remote sites. The interactive applications are preferably facilitated by synchronizing the commands at the headend to a specific video frame and a specific audio frame. This level of synchronization is achievable within the syntax of the MPEG-2, 4 or 7 specifications.

10

In order to facilitate the seamless switch at the reception sites, the video encoders 312 are preferably time synchronized. This synchronized start is necessary to ensure that the splice points that have been placed in the video content occur at the correct frame number. While it is not necessary to 15 obtain this level of accuracy for all program types, it is achievable in this matter. This provides content producers with the ability to plan video switch occurrences on a frame boundary within the resolution of the Group of Pictures (GOP). SMPTE time code or Vertical Time Code (VTC) information can be used to synchronize the encoders 312. Additionally, a splice can be 20 placed accurately at any frame by utilizing the variable length GOP. Upon command from an external controlling device such as the ACTV command code computer 316, the encoder 312 can be directed to insert a splice at a frame number. Making encoder modifications at the headend ensures more effective seamless switching at the set top converters.

25

As shown in Figure 5, multiple video signals 300, data codes 316 and audio signals 308 are input into the encoder 312. In the preferred embodiment, four video channels are input into the encoder 312. However, more or less video streams may be input based on the content that is to be 30 delivered. In the current environment, practical limitations for the number of videos are based on picture quality. Ultimately, however, there will be no limit to the number of videos and audios that can be contained within a single

channel. Further, all current limitations can be removed through the use of the alternate embodiment that describes a two tuner implementation.

Preferably, the encoder 312 uses a standard MPEG-2 compression
5 format. However, MPEG-4 and MPEG-7 as well as other compression
formats, such as wavletts and fractles could be utilized for compression.
These techniques are compatible with the existing ATSC and DVB standards
for digital video systems. Certain modifications, however, are made to the
MPEG stream in order to facilitate the preferred seamless switching at the set
10 top box. These modifications to the encoding scheme are described below
with reference to the video frame structure 332 shown in Figure 6.

Switches at the remote reception sites will occur at the video splice
point 336. Program switching is facilitated through the provision of splice
15 points. The splice points are identified within the program stream via the
adaptation field data. Program switching occurs at these points based on user
inputs, personal profile information stored in memory at either the set top
converter or the headend, and commands from the program source.

20 With respect to creation of the video splice point 336, the video encoder
inserts splice points at every Group of Pictures (GOP), as shown in Figure 6.
A GOP consists of generally one I frame and a series of P and B frames,
based on parameters set within the MPEG scheme. Preferably, the GOP is
encoded as a "closed" GOP structure, which means that the GOP concludes
25 on a P frame. Therefore, no motion vectors to the next GOP are present. If
motion vectors cross from one GOP to the next GOP, artifacts are created and
visible when the screen is switched. Thus, a closed GOP structure is
necessary for compliance with MPEG syntax and to ensure the absence of
visible artifacts after execution of the splice.

30

The GOP length is programmable and can be within 1 to infinite frames
of video. It is preferred, however, that the GOP comprise 10-15 video frames.

Referring to Figure 6, four video signals are shown. It is desired that a seamless switch be made from any video signal to any other video signal.

As shown in Figure 6, seamless video switching occurs on a GOP
5 video-frame boundary. For pre-recorded material, splice points need to be identified for switch points. For programming where "free" channel selection is required (e.g. sports), all GOP boundaries are encoded as splice points. While the switch must appear seamless, it need not occur immediately. For example, a command or key input requires a finite time for processing.
10 Therefore, a video switch may be delayed by up to 1.5 GOP's.

As shown in Figure 6, splices take advantage of the non real time nature of MPEG data during transmission through the digital channel to create a time gap 340 in which the decoder can be switched from decoding one
15 stream to decoding the other during the gap 340. Thus, the gaps 340 shown in Figure 6 represent the switch times. The key is that the most complex video is completed and through the channel before the first packet of the next GOP is through the channel. By encoding at a lower bit rate than the channel capacity, some extra time is created at the end of the GOP in order to switch.
20 In this way, two MPEG streams are merged to create a single syntactical correct MPEG data stream. These gaps can be created at the encoder 312, shown in Figure 5, using any compression scheme.

The audio signals, preferably, are encoded using the AC3 format. The
25 present invention, however, covers any conventional audio encoding scheme.

All of the various video, audio and data signals are digitized and combined in the encoder 312, in Figure 5. Preferably, the compressed and encoded signal is output in DS3, Digital High Speed Expansion Interface
30 (DHEI) or any other conventional format. The data type is not important, it is just data. The encode process then outputs a digital data stream at the appropriate bit rate for the target channel.

The modulator 320 may utilize one of several different possible modulation schemes. Preferably, 64-QAM is chosen as the modulation scheme. If so, the data rate at the output of the modulator 320 is around 29.26 Mbps. However, any of the following modulation schemes, with respective approximate data rates, or any other conventional modulation scheme (such as FSK, n-PSK, etc) can be used.

	<u>Modulation Scheme</u>	<u>Rate</u>
10	64-QAM	29.96 Mbps
	256-QAM	40 Mbps
	8 VSB	19.3 Mbps
	64 QAM PAL	42 Mbps
	256 QAM PAL	56 Mbps

15

Separate NTSC channels are then combined in a conventional combiner, preferably using frequency modulation. Thus, seamless switching at the set top converters can occur from one signal to another within one NTSC channel or from one NTSC channel to another NTSC channel, as discussed below.

20

In summary, seamless switching at the decoder is facilitated at the encoder 312 by time synchronizing the signals, time locking the encoders and creating a time gap 340 to each of the digital video streams (which represents the difference between the encode rate and the channel capacity) to GOPs, defined below.

25

After encoding, modulation and multiplexing, the signals can be transmitted to reception sites via satellite, wireless, land line, broadcast, or any other conventional transmission system. In the preferred embodiment, the signals are distributed to remote sites via cable or other transmission media.

30

Reception Sites

At the reception sites, for example, at a receiver as shown in Figure 7, the signal is received via tuner mechanism 344. The tuner 344 may be a wide band tuner, in the case of satellite distribution, a narrow band tuner for
5 standard MPEG signals, or two or more tuners for seamlessly switching between different signals located in different frequency channels, as explained below. In the case of MPEG signals, the tuner 344 tunes to the particular NTSC channel indicated from command by the host processor 360. The host processor 360 is preferably a Motorola™ 68331 processor, but may be any
10 conventional processor including PowerPC™, Intel Pentium™ etc.

The signal is then forwarded to the demodulator 364. The demodulator 364 demodulates the combined signal, strips off the FEC and forwards the digital signals to the video and audio decoder 372. At the digital decoder 372,
15 the signals are separated and decompressed. The decoder 372 strips off the program identification number (PID) and routes these PIDs to the appropriate decoder, whether video, data, audio or graphics. The audio is preferably forwarded to the Dolby™ digital processing IC 380. The selected video and audio is then decoded, as explained below, and the video is sent to the video
20 digital-to-analog (D/A) converter 388 which prepares the selected video for display.

A phase lock loop (PLL) recovers the encode clock, which was encoded in the PCR portion of the MPEG adaptation field. Preferably, a ROM holds the
25 operating system for the reception unit 342 and is backed up with Flash-ROM to allow for downloadable code. Further, there are memory devices connected to the decoders 372, 380 and graphic chip 376, which are used to store graphics overlays, for example. Furthermore, profile data for various users in the home can be stored in nonvolatile RAM or ROM 352.

30

A backchannel encoder and modulator 368 are present for sending data back to the headend. Such data may comprise personal profile

information, interactive selections, demographic data for targeted advertising purposes, game show scores, etc.

5 Further, the reception unit 342 permits new software applications to be downloaded to the unit. These applications can control the unit and redefine the functionality of the units within the constraints of the hardware. Such control can be quite extensive, including control of the front-panel display, the on-screen display, all input and output ports, the MPEG decoder, the RF tuner, graphics chip and the mapping of the IR remote functions.

10

Preferably, the interactive programming technology, including providing for multiple camera angles, individualized advertising etc., is implemented as a software application within the reception unit 342. Such technology is preferably located within ROM or Flash-ROM 352 of the reception unit, shown
15 in Figure 7. The interactive technology, however, could alternatively be located in any type of memory device including RAM, EPROM, EEPROM, PROM, etc. As such, the software has access and control over the hardware elements of the device. No additional hardware is required for full use of the interactive programming technology within the reception unit 342 to achieve
20 the performance described above.

Any type of conventional remote control device 348 may be used. It is preferred, however, that the remote control device 348 be an infrared (IR) device and include four or more option buttons and their associated IR codes.

25

Seamless video switching at the reception unit 342 is explained in the paragraphs below. The reception unit 342 shown in Figure 7 preferably is capable of real-time MPEG-2, MPEG-4 or MPEG-7 decoding. The reception unit 342 monitors user interactions and information transmitted from the
30 program source and seamlessly switches video and audio streams as appropriate.

Based upon the viewer's responses and requests, the unit automatically and seamlessly switches between video, graphics and audio programming sequences reflecting the viewer's earlier responses. The interactive technology permits a high level of interactivity while not requiring the set top
5 unit 342 to transmit any information back to the programming source.

In the video decoder 372 shown in Figure 7, the header data is stripped off the MPEG stream. The particular video is then selected based on a command from the host processor 360. The associated audio is sent to the
10 audio decoder portion 380. The selected video is buffered in a standard video buffer and then output for decoding. The physical buffer size is defined by the MPEG standard. Enough time must be allowed at the initial onset of decoding to fill up the buffer with I-frame and other data.

15 After buffering, the selected video goes through various steps of an MPEG decode process, which utilizes a variable length decode (VLD) preferably. Generally, the variable length decode converts the run-length encoded datastream and converts it into its longer bitstream format. The bitstream is decoded into its constituent parts i.e. motion vectors, dct
20 coefficients and the like so that the video can be reconstructed. Subsequently, the datastream is converted into frequency domain information using an inverse Discrete Code Transform DCT filter. If the frames are intercoded, the pixel data is generated and stored in a buffer.

25 Referring to Figure 7, the seamless switch from one to another MPEG video stream is explained. Switches will occur on video splice points, as shown in Figure 6. When the demux/decoder 372 in Figure 7 sees the splice point, it switches to the selected video signal which is sent to the buffer. Thus, prior to the switch, the first video signal frames are still being buffered. The
30 next signal PID is loaded into the decoder 372 from the host processor 360. In order to accomplish a switch to one of the four video streams, the video decoder 372, shown in Figure 7, must identify the PID number of the new

video stream. Further, it is preferred that each incoming video and audio stream shall have its own PID, known to the interactive application stored in memory at the set top converter 342, in order to facilitate seamless switching among the independent video and audio streams. It must then call the routine that performs the switch. This next PID, identifying the next selected video signal, can be based on either user selection or by way of the interactive control codes or both. Once the next PID is loaded, the decoder 372 begins to look for the selected video stream and, because of the gap 340 created in the video datastream, the decoder 372 will always find the header information of the next video. Once the splice point indicator of the first video is seen by the decoder 372 and the second video signal is identified by the decoder 372, the second compressed video signal begins to load into the buffer as the first video signal continues to play out. The new video signal is selected based on either user selection or based on an interactive control code.

15

One of the items necessary for a seamless switch is the splice point counter and a splice point flag. Both of these indicators are placed in the adaptation field of the MPEG video streams. The splice point counter indicates the number of video packets prior to the splice point. The splice point flag indicates that the splice count is present in the stream. Once the decoder 372 determines the splice point, it can begin buffering the next video stream and continue decompressing the signal as if it were one MPEG stream.

20

Audio Switching

As with the video streams, preferably four AC-3 audio streams, each of which is identified by a unique PID, exist per service. PID numbers are obtained from the MPEG-2 transport table such as SI, PG, and PM at the invocation of the interactive service. One of these PIDs is selected as the default audio channel and is selected upon acquisition of a service. The remaining three channels are optional and are selected by the control program based on control messages and/or user input. While audio channels normally

25

30

switch with the associated video channel, they may also be switched independently.

In the preferred embodiment, switching occurs on frame boundaries, as shown in the digital frame representation 392 of four audio streams of Figure 8. When switching from one channel to another, one frame may be dropped (in this case, frame 5), and the audio resumes with frame 6 of the new channel. The audio decoder 380 is capable of audio switching by provision of the insert of audio splice points at the encoder 312, shown in Figure 5. Preferably, the encoder 312 inserts an appropriate value in the splice countdown slot of the adaptation field of the current audio frame.

When the audio decoder 380 detects this splice point the decoder 380 may switch audio channels. Although the audio splice is not seamless, the switch will be newly imperceptible to the user.

Data Commands

Because the data commands are time sensitive in the digital embodiments, they are sent from the headend via a command data PID (Packet Identification). The commands must be synchronized with video GOPs at the encoder end. In order to accomplish this, the data codes computer 316, shown in Figure 5, must send individual commands as a whole packet. Each command can consist of as few as two bytes. Therefore, the generator must pad the rest of the packet with code FF (hex) bytes. When this whole packet is sent to the encoder 312, the encoder 312 will transmit it at its earliest convenience. If a partial packet is sent to the encoder 312, the encoder 312 does not send the command until subsequent commands fill the remainder of the packet.

The commands, as identified in (1) ACTV Coding Language, Educational Command Set, Version 1.1, and (2) ACTV Coding Language, Entertainment Command Extensions, Version 2.0, are formed by stringing

together two or six byte long commands. The command data is presented to the encoder's ISO interface and packet stuffed to ensure timely transmittal of the command data.

5 The control program is preferably stored in RAM 352. The processor 360 receives instructions from the control program. Further, key inputs such as user responses, personal profile information as well as control messages are used by the processor 360 in making switching decisions.

10 Preferably, the control program operates in five modes as determined by the received interactive command messages. The five modes are as follows:

- Switch Audio and/or Video Based on User Input
- Switch Audio based on User Input and stored data
- 15 • Switch Audio and/or Video based on User Input and stored data
- Switch Audio and/or Video based on Control Messages
- Switch Audio and/or Video based on Control Messages and stored previous input.

Multiple modes may be used by the program simultaneously.

20

The first mode above, "switch audio and video channels", is the simplest mode of operation. The control program is commanded by the microprocessor 360 to accept one of the four remote input key codes and to switch to the corresponding audio/video channel. The program performs this switch on the video frame boundary at the end of the current GOP. Once the new channel is displayed, the program has the capability to update the on-screen display with new text and/or graphics messages either received in the datastream from the headend or stored locally.

30 The second mode above, "display one video channel and switch audio channels", continuously displays a single video channel. When a remote input key code is received, the video continues but the audio channel is switched on

the appropriate audio frame boundary. As mentioned above, the appropriate audio frame boundary is determined by examining the splice point counter value in the adaptation field. The choice made by the user is stored in a RAM register. Any time a choice is made by the user, the key code and the
5 previously stored choices are reviewed by the program to determine the next audio channel.

The third mode identified above, "switch audio video channels based on user and previous choices", displays an initial audio/video channel. When
10 commanded by the command message stream, text is displayed on the on-screen display. The program then waits for a user input. When the user input is received, it is stored in a RAM register along with previous user choices. The register is examined by the program and then, based on stored logic, determines the next audio/video channel to be displayed.

15

The fourth mode identified, "switch audio/video channels based on control messages", also displays an initial audio/video channel. The program then waits for a control input from the control message stream. Based on this input, the program switches channels on the video frame boundary at the end
20 of the current GOP.

The fifth mode above, "switch based on control messages and previous choices", displays an initial audio/video channel. The program then waits for a control input from the control message stream. When the control message
25 input is received, it is stored in a RAM register along with the previous user and control message choices. This register is then examined by the program to determine the next audio/video channel to be displayed.

Digital Video Systems and Applications

30 The following paragraphs disclose several applications using the digital embodiments disclosed above in Figures 1 to 8 and the two tuner embodiments, described below, of Figures 16 and 17.

TV Broadcast Station Switching

In this embodiment 412, the seamless switch from one signal to another signal is done at a TV broadcast control center and forwarded to the users' digital reception sets 408, as shown in Figure 9. At the headend 396, several digital programs are combined according to any of the methods explained above.

Upon receipt of the programs by the broadcast station, the signals are fed into a digital stream selector 400. This selector comprises the elements discussed above in any of the alternative embodiments for performing a seamless switch (Figures 1 to 4, 7, 15 to 17), except for the fact that this unit is not located at the remote sites. The unit works in the same manner as discussed above. Regardless of whether the digital stream selector 400 selects amongst multiplexed signals in one datastream on one channel, centered on a certain frequency, or between signals in different datastreams, or from a received signal to a locally inserted ad, all such switches are seamless in the embodiment shown in Figure 9. As discussed above, selections can be made as a function of station prerogative, remote user selections and/or personal profile information (transmitted to the TV station via a backchannel), or targeted advertising.

Once a selection is made the program signal is transmitted by any conventional means 404 to the remote sites 408 for presentation.

Non-related Program Switching

Figure 10 discloses an embodiment 430 for switching between non-related programs. In other words, this is simply switching from one TV channel to the next TV channel. Presently, switching from one signal to another cannot be accomplished without flicker in the digital environment. The systems described herein enable a viewer to switch from one program to another program, whether related or unrelated, and the transition will be

seamless. In other words, there will be no visible artifacts present in switching from one program to another program.

5 If the programs are compressed and multiplexed within one MPEG stream, any of the embodiments disclosed herein are capable of performing the seamless switch. If the programs are in separate NTSC channels, one of the digital "two tuner" embodiments (Figures 4, 16 and 17) must be used to allow for the frequency shift.

10 The high level elements of the system 430 for non-related program switching are shown in Figure 10. Preferably, the non-related programming is compressed and multiplexed using an MPEG stream into one datastream using one NTSC channel at a video encoder chassis 416. Non-related programming can be combined into one MPEG stream or can be directed into
15 different NTSC channels. For example, programming may consist of sports, news, sitcom or children' programming. These programs are modulated at a modulator/upconverter 420 and transmitted across any suitable transmission means 429 as discussed above.

20 End users are capable of viewing digital programming on either a digital monitor/tuner, a personal computer or through an external converter 428, connected to an analog television set, in which case the seamless switch is performed in the converter. Either of these various components allows a user to "surf" channels based on a viewer's preferences. Again, the reception unit
25 can be selected from any of the alternatives explained in Figures 1 to 4, 7, and 15 to 17.

Seamless Switching within Multiple Event Programming

30 In the application shown in Figure 11, a system 450 is provided for allowing a user to switch between separate events within a single program. For example, an Olympics broadcast may simultaneously comprise several programs corresponding to different events, e.g. skiing, speed skating, figure

skating, ski jumping etc. Preferably, these separate event programs are compressed and multiplexed into one MPEG digital stream at the video encoder chassis 434, passed through the modulator/converter 438 and transmitted as a single NTSC signal via the transmission means 442. These
5 event programs, however, may also be encoded at the broadcast center onto separate channels.

After modulation and subsequent transmission, these programs are received at the remote sites 446. The remote sites 446 include a reception
10 unit, which contains either a digital monitor/tuner, a personal computer, or a external digital converter connected to a monitor. The user may select between the different programming events via his or her remote control device. When he user desires to switch to another event program, the switch will be performed seamlessly by any of the methods and systems discussed
15 above.

Seamless Picture-in-Picture Switching

Figure 12 discloses an embodiment 470 for switching between preferably non-related programs using "picture-in-picture". Regardless of
20 whether the user is switching between programs in the small framed display or the large framed display, all such switches are seamless with the systems and method described.

A viewer may switch from one program to another program, in either of
25 the two displayed windows. In other words, there will be no visible artifacts present in switching from one program to another program.

The high level elements of the system for picture-in-picture program switching 470 are shown in Figure 12. Preferably, four to seven programs are
30 compressed and multiplexed into an MPEG stream into one datastream on one NTSC channel at the video encoder chassis 454. Other programs are combined into other MPEG datastreams at the video encoder chassis 454.

For example, programming may consists of sports, news, sitcom or children's programming. These programs are modulated and transmitted across any suitable transmission means 462, as discussed above.

5 End users are capable of viewing digital programming on either a digital monitor/tuner, a personal computer or through an external converter 466, connected to an analog television set, in which case the seamless switch is performed in the converter. The embodiment and flow disclosed in Figure 12
10 allows a user to invoke the picture-in-picture feature and seamlessly switch between different programs within a single MPEG stream. If switching from MPEG multiplexed stream to another is desired, the converter, PC or digital monitor/tuner 466 will require the employment of a multiple tuner/decoder, examples of which are shown in Figures 4, 16 and 17.

15 Switching within Multiple Commerce/Shopping Programming

 A transaction based system, with return paths, is shown in Figure 13. As with the other embodiments discussed above, the video encoder 474 compresses and multiplexes several different programs onto one or more NTSC channels for transmission to the remote sites.

20 Preferably, several different types of shopping programs are compressed and multiplexed onto a single NTSC channel. For example, separate programs may be directed at clothes, jewellery, housewares, etc. If more programs are necessary than allowable on a single NTSC channel, more
25 than one NTSC channel may be utilized.

 The programs are transmitted to the end user reception units 486, as shown in Figure 13, over any suitable transmission means 482. At the reception units 486, the user can seamlessly switch between different product
30 genres. Alternatively, the reception unit 486 can switch to certain product programming based on personal profile or demographic information. In this manner, only those products which most closely match or suit a particular

individual's interests and desires will be presented to the user. Such data can be stored in either storage in the reception unit 486 or at the headend.

5 If the user decides to purchase a product, or to receive additional information regarding a product, the backchannel 490, such as that shown in Figure 10, can be used to transmit such requests back to the central location.

Digital Program Insertion – Addressing Advertising

10 Figure 14 discloses an embodiment 526 for providing digital program insertion. At predetermined times during the programming, certain advertisements are displayed to the viewer. The advertisements may be individualized to the particular viewer based on personal profile information and/or demographic information. Such targeted advertising is described in the following paragraphs.

15 At the central location, a plurality of advertisements is inserted into the programming stream. Preferably, the central location uses a hybrid digital insertion system for insertion of the advertisements into the programming. Hybrid digital equipment replaces the tape decks of the analog system with
20 computers, disk drives and decoder cards, as set forth in the CableLabs Cable Advertising White Paper. The advertising content 506 may originate from any one of a number of possible sources, including, but not limited to, server, tape decks, satellite feed. For storage, preferably the spots are digitally encoded and compressed in an off-line process, using MPEG1, MPEG5, MPEG2, or a
25 proprietary method. Distribution from the encoder to the server and to the playback systems can be done through a network or by disk or tape.

After encoding, the spots are distributed to a server for storage until required for playback. Preferably, a spot can be played directly from the
30 server to a decoder card, for conversion back to analog. The spot is converted to analog, then sent through the insertion switcher in the conventional manner. The output video and audio would then be forwarded to

the audio and video encoder shown in the central site configuration in Figure 5, after which the spots are digitally encoded and compressed as described in the paragraphs above, with reference to Figure 5.

5 Although not as efficient as digital advertising insertion, the actual switching of the advertising into the programming can also be accomplished with conventional advertising insertion systems, using analog or tape based systems.

10 The placement and display of advertisements into the programming stream are controlled through the use of signalling and addressability command insertion 498. Personalized advertising can be effectuated by addressing chosen advertisements to particular viewers. For example, a car
15 company wants to individualize its commercial to best meet the needs and desires of the viewer. If it is known that a particular user is male and enjoys outdoor activities, the programmer may want to show the advertisement corresponding to the car company's sports utility vehicle as opposed to a small economy car. The advertisements can be pushed to the end user based on
20 data stored at the remote end user unit or in the stream addressed to the end users device via the set-top controller in the provider's headend.

 Preferably, several advertising options are encoded as described above with reference to Figure 5. Because the advertising spot videos are genlocked and time synched at the encoder 510, switching from the main programming to
25 one of the advertisements will appear seamless to the viewer.

Seamless Switching from a Group of Signals to another Group of Signals at a Server

30 In another embodiment, the process of switching among live and served video content is described. As opposed to switching from a single digital signal to another single digital signal at the remote reception units, this embodiment allows for a seamless transition from one group of signals to

another group of signals. It is necessary that the transition take place in a manner such that the output bitstream is continuous and correct to the MPEG syntax. Proper switching ensures that any standard MPEG decoder plays the resulting bitstream as if it were a stream with no errors.

5

The preferred embodiment 530 for performing this switch is shown in Figure 15. The elements of Figure 15 are located at a cable headend or alternatively, at a centralized op center for a satellite distribution network. For purposes of explanation, a group of live signals are denoted as the Group A signals and the Group B signals are presumed to be stored prerecorded signals, preferably stored at the server 550. For example, the Group A signals may comprise several videos representing different camera angles or a sporting event. The Group B signals may represent a series of commercials. It is understood, however, that both the Group A and/or Group B signals could represent either prerecorded or live signals.

In this embodiment it is desired to switch from the Group A signals to the Group B signals. The Group A signals are received at the server 550 from a real-time encoder 546, located either locally or at a remote site. A specialized MPEG digital packet is inserted into the Group A content stream on a specific channel. The command and control terminal 534 provides an analog tone in the video signals prior to analog-to-digital conversion. Once the signals reach the real time encoder 546 from the command and control terminal 534, the real time encoder 546 inserts a digital tone at the appropriate point in the Group A digital stream upon detection of the analog tone. Once the tone is inserted, the Group A digital stream is output from the real time encoder 546 and forwarded to the server 550 at the headend. Once received at the server, the Group A stream is forwarded to an MPEG transport switch device in the server 550. The control terminal 538 sends a command to the MPEG transport server switch device to cause the switch to begin looking for the inserted digital tone.

In order to play back the Group B content, the server switch device must decode timing information from the Group A digital stream and subsequently, restamp the Group B content with the appropriate timing signals from Group A. Preferably, this is accomplished by genlocking to the PCR's
5 videostream, preferably the same stream with the digital tone embedded therein, and stripping out the program clock reference (PCR) out of the videostream to recreate the encode clock of the original Group A content. At this point, the switch device has the ability to re-insert the timing information into the Group B content to prepare it for playout.

10

Upon detection of the digital tone, the server switch device initiates a transition to the Group B digital stream, comprised of the Group B prerecorded signals. Preferably, the server switch device has prior knowledge of the length of the Group B content and, therefore, when the server switch device senses
15 the end of the Group B content, it switches back to the Group A content. The resulting digital stream output from the server to the transmitter comprises both Group A and Group B content. The transmitter 554 forwards the digital data stream to the remote reception sites, as previously described.

20 In this manner, at certain times during the presentation of a sporting event, represented via the plurality of live digital video signals (i.e., the Group A content), for example, the received videostream at the receive converter units will automatically transition to the Group B prerecorded content based on the action by the server switch device, for example. The decoder at the
25 reception sites then selects one of the advertisements in the Group B content, as previously described. At the end of the advertisements the decoder automatically begins receiving the Group A content again and selects one of the live signals, as previously described. In this manner, a seamless switch from live encoded video content to prerecorded content is effectuated at the
30 server.

Two Tuner Embodiments for Seamless Switching

Digital Stream to Digital Stream Switch

A two tuner embodiment 558 for providing seamless switching from a digital signal located in one frequency channel (hereinafter, "Channel A") to
5 another digital signal located in another frequency channel (hereinafter, "Channel B") is shown in Figures 16A and 16B. In this embodiment, two tuners 560A, 560B (for tuning to separate frequency channels), a microprocessor 564 (for selecting the frequency channels and digital signals embedded therein), digital demodulators 568A, 568B (for demodulating the
10 signals from the carrier), a digital demux/decoder 572 (for stripping out the selected audio, video and data of the selected content from the composite digital stream) and a display processor 576 (for formatting the video signal for display) are provided.

15 This embodiment operates to switch from one digital data stream in Channel A to another digital data stream in channel B as follows. A first tuner 560A is tuned to Channel A and is receiving a composite digital stream, preferably comprising a plurality of digital video, audio and/or data signals, in the associated frequency channel. The composite digital stream is passed
20 from the first tuner 560A to a digital demodulator 568A. The type of demodulation can be any suitable type.

The composite digital stream is then directed to the input of the digital demux/decoder 572, wherein the selected audio and video signals are
25 stripped from the composite digital stream in a demux 573 and forwarded to the audio and video decoders 575, 574, respectively. Those signals are then decompressed and decoded based on the signal encoding scheme, preferably one of the MPEG schemes. Once decoded, the audio and video (and/or data, if appropriate) are forwarded to the display processor 576 and subsequently to
30 the monitor.

Once a decision is made to switch to another digital signal in frequency Channel B, the microprocessor 564 sends a command to the second tuner 560B to pretune to the Channel B frequency. The composite digital stream in Channel B is passed through the digital demodulator 568B and forwarded to the digital demux/decoder 572. At this time, digital demultiplexer 572 receives both the digital streams located in channel A and Channel B. Thus, if both Channel A and Channel B carried four digital signals, the demultiplexer 572 receives eight digital signals. The digital demultiplexer 572 receives a command from the microprocessor 564 indicating which of the digital signals to strip out from the composite digital stream from Channel B. Separately, the digital demultiplexer 572 strips out the selected video and audio (and/or data) signals from the composite digital streams from Channels A and B. The selected signals are forwarded to the video and audio decoders 574, 575. The video decoder 574 switches from the currently displayed video signal to the newly selected video signal as described above with reference to Figures 6 and 7. Therefore, the decoder 574 identifies the splice point in the present stream. Once the decoder 574 detects the splice point, it determines that it is the appropriate time to switch to the second stream. The decoder 574 begins loading the second stream into the buffer and a seamless switch is effectuated because of the time gap in the first stream. Once the second stream is output from the decoder, it is forwarded to the display processor 576, where the video signal is formatted for display.

The audio decoder 575 performs the switch from the present audio stream to the second audio stream, in the same manner as described above with reference to Figure 11. Once the switch is completed, the second audio stream is forwarded to the display processor 576.

Switch from Analog Signals to Digital Signals or Digital Signals to Analog Signals

A two tuner embodiment 590 for switching from an analog signal located in a first RF channel to a digitally compressed signal in a second RF

channel or vice versa is shown in Figure 17. In this embodiment, a viewer is watching a particular channel, whether it be an analog or digital signal, in one specific RF frequency and there is a decision made to switch to another channel, whether it be analog or digital, in a different RF frequency. Two
5 tuners 560A, 560B are used to transition from one RF frequency to a different RF frequency.

Assuming by way of example that the viewer is currently watching a channel (Channel A) with an analog signal and the decision is made to switch
10 to a digitally compressed signal in a different channel (Channel B), the embodiment of Figure 17 operates as follows. With respect to the analog signal, one of the tuners 560A tunes to the RF frequency associated with Channel A. Because the channel carries an analog signal, the tuner 560A directs the signal to the analog demodulator 569A and VBI decoder 570A.
15 The analog demodulator 569A demodulates the analog signal using any conventional analog demodulation scheme known in the art. The VBI decoder 570A strips out any information (e.g., interactive commands, close captioning) embedded in the vertical blanking interval (VBI). The demodulated analog signal is then forwarded to the analog display processor 580, which formats
20 the analog signal, and then outputs it to the VBI switch 588 and then display device.

If a decision is made to switch to a channel containing mixed and compressed digital signals, the microprocessor 564 determines the RF
25 frequency location of this channel and forwards the information in a command to the second tuner 560B. Upon receipt of the command, the second tuner 560B pre-tunes to the indicated second RF frequency (Channel B). The output of the Channel B is forwarded to the input of the digital demodulator 568B, which demodulates the signal using any of the digital demodulation
30 schemes known in the art. The digital data stream is output from the demodulator 568B and received at the digital demux/decoder 572. The microprocessor 564 sends a command to the digital demux/decoder 572

indicating the selected digital signal. The digital demux/decoder 572 demultiplexes the plurality of digital signals and decompresses such signals. The resulting selected constituent parts (audio, video and data) are then forwarded to the appropriate decoders 574, 575 (see Figure 16B), as
5 described above with reference to Figure 16, whereby the video decoder 574 begins to decode the video information and sends a signal to the microprocessor 564 signalling that the stream was properly decoded and that the audio was in lip synchronization.

10 The video and audio signals are then forwarded to the digital display processor 584, wherein the signals are converted from digital to analog. The resultant analog signals corresponding to Channel B are then input into the VBI switch 588. Upon command from the microprocessor 564 to switch the two videos, the VBI switch 588 switches during the appropriate time during the
15 vertical blanking interval resulting in a switch from the analog to the digital channel

If it is desired to switch from a digital channel to an analog channel, the process identified above is simply reversed and the second tuner 560B pre-
20 tunes to the analog channel. Further, the embodiment shown in Figure 17 can switch from analog to analog channels.

It will be appreciated that variations in, and modifications to, the embodiments described and illustrated herein may be made within the scope
25 of this application as defined in the accompanying claims.

A method for performing a seamless switch between two digital video signals and a receiver for performing the seamless switch as described herein are described and claimed in our copending application No. 2349289 from
30 which the present application is divided.

CLAIMS

1. A reception unit for receiving programming and capable of performing seamless switches from either a first analog signal to a second analog signal,
5 an analog signal to a digital signal, or a first digital video signal to a second digital video signal, comprising:
a microprocessor, for selecting one of the video signals and directing a seamless switch to the selected video signal;
a pair of tuners, connected to the microprocessor, for tuning to RF
10 channels, wherein the pair of tuners selects the RF channels on command from the microprocessor;
a pair of analog demodulators, each analog demodulator connected to one of the tuners, and capable of receiving one analog signal;
a pair of digital demodulators, each digital demodulator connected to
15 one of the tuners, and capable of receiving one digital signal;
a digital demultiplexer/decoder, connected to the pair of digital demodulators, for demultiplexing digital signals, decompressing the digital signals, and for performing a seamless switch from one digital video signal to another digital video signal;
20 a digital display processor, connected to the output of the digital demultiplexer/decoder, for converting the decompressed output digital signal to an analog signal; and
a vertical blanking interval switch, operably connected to the output of the digital demultiplexer/decoder and the output of the analog demodulator, for
25 seamlessly switching between the analog video signals.
2. A reception unit as claimed in Claim 1, wherein the switched to digital video signal comprises two video programs in a picture-in-picture format.
- 30 3. A reception unit as claimed in Claim 1 or Claim 2, wherein at least one of the video signals is received from one of the group consisting of a satellite

transmission system, a cable transmission system, a broadcast transmission system, a private network, and an in-stadium network.

4. A reception unit as claimed in any preceding claim, wherein the
5 reception unit is selected as one of the group consisting of a computer workstation with a television card, a television operably connected to an analog cable set top box, a digital television, a television operably connected to a digital cable box, and a television operably connected to a computer workstation.
10
5. A reception unit as claimed in any of Claims 1 to 3, wherein the reception unit is located at a broadcast station and further comprises means for transmitting the signals to remote sites.
- 15 6. A reception unit as claimed in any preceding claim, wherein at least one of the two video programs of the switched to digital video signal corresponds to a predetermined camera angle.
7. A reception unit as claimed in any preceding claim, wherein at least one
20 of the two video programs of the switched to digital video signal corresponds to a main program feed.
8. A reception unit as claimed in any preceding claim, wherein at least one
25 of the two video programs of the switched to digital video signal is selected from the group consisting of a live program event and a pre-recorded program event.
9. A reception unit as claimed in any preceding claim, wherein at least one
30 of the two video programs of the switched to digital video signal corresponds to a replay.

10. A reception unit as claimed in any of Claims 1 to 5, wherein at least one of the two video programs of the switched to digital video signal corresponds to a main program feed and the other digital video signal corresponds to one selected from the group consisting of a replay, a predetermined camera angle,
5 an advertisement, an individual focus, slow motion video, and player statistics.

11. A reception unit as claimed in Claim 1 or Claim 2, wherein at least one of the video signals is received from one of the group consisting of a digital video disk, a CD ROM, and a computer hard drive.
10

12. A reception unit as claimed in any preceding claim, wherein the switched to analog video signal comprises two video programs in a picture-in-picture format.

15 13. A reception unit as claimed in Claim 12, wherein at least one of the two video programs of the switched to analog video signal corresponds to a predetermined camera angle.

14. A reception unit as claimed in Claim 12 or Claim 13, wherein at least
20 one of the two video programs of the switched to analog video signal corresponds to a main program feed.

15. A reception unit as claimed in any of Claims 12 to 14, wherein at least one of the two video programs of the switched to analog video signal is
25 selected from the group consisting of a live program event and a pre-recorded program event.

16. A reception unit as claimed in any of Claims 12 to 15, wherein at least one of the two video programs of the switched to analog video signal
30 corresponds to a replay.

17. A reception unit as claimed in Claim 12, wherein at least one of the two video programs of the switched to analog video signal corresponds to a main program feed and the other video signal corresponds to one selected from the group consisting of a replay, a predetermined camera angle, an advertisement, an individual focus, slow motion video, and player statistics.

18. A seamless switching unit for receiving programming and performing a seamless switch from a digital video signal multiplexed in a first program signal received in a first RF channel to an analog video signal multiplexed in a second program signal received in a second RF channel, comprising:

- a microprocessor, the microprocessor directing the switch from the digital video signal to the analog video signal;
- a first tuner, connected to the microprocessor, for tuning to the first RF channel;
- a digital demodulator, connected to the first tuner, for demodulating the first program signal;
- a digital demultiplexer/decoder, connected to the first digital demodulator and microprocessor, for demultiplexing the first program signal to obtain the digital video signal, and decompressing and decoding the digital signal;
- a digital display processor, connected to the digital demultiplexer/decoder, for converting the digital video signal to analog;
- a second tuner, connected to the microprocessor, the second tuner pre-tuning to the second RF channel;
- an analog demodulator, connected to the second tuner, for receiving and demodulating the analog signal;
- a vertical blanking interval switch, operably connected to the output of the digital demultiplexer/decoder and the output of the analog demodulator, for seamlessly switching from the converted digital video signal to the analog video signal during the vertical blanking interval of the signals.

19. A seamless switching unit as claimed in Claim 18, wherein the analog video signal contains two video programs to be displayed simultaneously in a picture-in-picture format, and the switching unit further comprising:
a display device for displaying simultaneously the two video programs
5 contained in the analog video signal in either a side by side or in a picture-in-picture format.
20. A seamless switching unit as claimed in Claim 18 or Claim 19, wherein the digital video signal and the analog video signal contain non-related
10 programs.
21. A switching unit as claimed in any of Claims 18 to 20, wherein at least one of the first and second program signals are received from one of the group consisting of a satellite transmission system, a cable transmission system, a
15 broadcast transmission system, a private network, and an in-stadium network.
22. A switching unit as claimed in any of Claims 18 to 21, wherein the switching unit is selected as one of the group consisting of a computer workstation with a television card, a television operably connected to an
20 analog cable set top box, a digital television, a television operably connected to a digital cable box, and a television operably connected to a computer workstation.
23. A switching unit as claimed in any of Claims 18 to 22, wherein at least
25 one of the two video programs of the switched to analog video signal corresponds to a main program feed.
24. A switching unit as claimed in any of Claims 18 to 24, wherein at least
30 one of the two video programs of the switched to analog video signal corresponds to a predetermined camera angle.

25. A switching unit as claimed in any of Claims 18 to 24, wherein at least one of the two video programs of the switched to analog video signal is selected from the group consisting of a live program event and a pre-recorded program event.

5

26. A switching unit as claimed in any of Claims 18 to 25, wherein at least one of the two video programs of the switched to analog video signal corresponds to a replay.

10 27. A switching unit as claimed in any of Claims 18 to 22, wherein at least one of the two video programs of the switched to analog video signal corresponds to a main program feed and the other video signal corresponds to one selected from the group consisting of a replay, a predetermined camera angle, an advertisement, an individual focus, slow motion video, and player
15 statistics.

28. A switching unit as claimed in any of Claims 18 to 20, wherein at least one of the video signals is received from one of the group consisting of a digital video disk, a CD ROM, and a computer hard drive.

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Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.S): H4F (FGG FGH FGS FGT)

Int Cl (Ed.7): H04N 7/24

Other: Online: WPI, EPODOC, JAPIO

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
Y	WO 97/29458 A1 ACTV See especially page 16 line 13 to page 28 line 6.	1-28
Y	WO 96/37075 A1 ACTV See whole document, especially page 16 line 12 to page 20 line 4.	1-28
Y	US 4625235 WATSON See especially column 4 lines 23-46.	1-28

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